# The Toolbox Medical Construction Contracting Vehicles of the U.S. Army Medical Command

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Abstract

The U.S. Army Medical Command (USAMEDCOM) currently uses a set of pre-negotiated, indefinite delivery/indefinite quantity (IDIQ) contracts, called Toolbox, designed to streamline the traditional solicit/bid/design, solicit/bid/build contracting process. Under Toolbox, facility managers can execute nominal design and/or construction projects via delivery orders issued against the existing pre-negotiated contracts. Toolbox contracts are managed by three U.S. Army Corps of Engineers (USACE) Medical Support Teams (MSTs): Fort Worth (which executes projects via medical job order contracts [MEDJOCs]); and Mobile and Huntsville (which execute projects via “Remediation” contracts).

The literature review indicates that IDIQ contracts produce faster, cheaper, and higher quality projects than traditional contracting means, but no known study has compared the three MSTs to each other in those same terms. The objectives of this study were to explain the similarities and differences between the three MSTs’ methods and determine if any MST was best-suited to execute projects of a certain scope by evaluating cost, timeliness, and quality of a sample of projects,.

This study developed 17 scope categories (i.e.

veterinary clinic, inpatient area, HVAC, electrical, etc.). Each scope category had a unit of measure (e.g. square footage, chiller tonnage, etc.) by which to compare projects of differing magnitudes.

The study considered 2800 projects from two USAMEDCOM databases. After filtering based on available data, and grouping into scope categories, 65 remained.

Insufficient data existed in the databases to measure quality, or timeliness. Though a single factor ANOVA revealed that cost data n-values were too low to be statistically significant, evidence indicates that Mobile may produce the lowest cost per unit of measure, and lowest cost overruns for the majority of relevant subcategories.

The study recommended corrections to specific USAMEDCOM data collection/storage problems, and suggested a framework for a systemic MST evaluation program.

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## Introduction

### Conditions which prompted the study

In the early 1990s, many, if not most, Army Medical Treatment Facilities (MTFs) were in a vicious cycle—the physical condition of the MTFs was rapidly deteriorating, and most facilities did not have a facility manager (FM) qualified to turn the trend around. The maintenance of each facility was the responsibility of the installation's Directorate of Public Works (DPW)[1]. At many installations, particularly those whose healthcare facility was not a medical center per se, the MTF's representative to the DPW was the Logistics Division's Chief of Environmental Services. The Chief of Environmental Services managed work/service orders and access of the DPW to wards, clinics, and administrative areas. Management of the facility in terms of linen, housekeeping, security, transportation, and maintenance work orders was the primary responsibility of the Chief of Environmental Services. This individual rarely possessed full knowledge in all technical areas to adequately supervise the numerous aspects of maintaining an MTF’s physical plant (Roberts & Trudzinski, 1998).

The Chief of Environmental Services relied on the DPW because the DPW was charged with the responsibility to fund, and make all repairs in the MTF. Unfortunately, the DPW often did not respond to the MTF’s requests for service in a timely enough fashion, and the Chief of Environmental Services could not usually negotiate with the DPW from any position of authority because the MTF competed with other base operations (BASOPS) for support (Arnold & Trudzinski, 1998). The U.S. Army Medical Command (USAMEDCOM)[2] needed to initiate steps to establish qualified facility management branches at each MTF, as well as devise a method that would enable MTFs to repair and upgrade their facilities more quickly than the then current contracting methods allowed.

<u>The facility management and facility support program concepts.</u>

In 1994, USAMEDCOM established Facility Management branches at each MTF. Concurrently, USAMEDCOM gained approval to allow FMs to hire contractors to maintain the facility if the DPW support was either more expensive, less timely, or of insufficient quality. To assist these FMs, USAMEDCOM established the Facility Support Program (FSP). The FSP consisted of the Sustainment Directorate, the

Technical Assistance Team (TAT), Medical Support Teams (MST), and the USAMEDCOM Central Contacting Office (CCO) (Arnold & Trudzinski, 1998). The development of the FSP enabled the fledgling FMs to access a similarly new contracting tool—USAMEDCOM Toolbox.

The Toolbox concept.

Toolbox is the collective name given to a set of pre-negotiated contracts engineered to provide rapid design and execution of a wide variety of projects pertaining to healthcare facility management. The Toolbox is composed of a variety of similar types of IDIQ contracts. These contracts are similar to the Blanket Purchase Agreements (BPA) used in the medical logistics community. This concept is based upon the premise that anticipated repetitive requests for supplies can be simplified by negotiating a contract regionally or nationally for the items, then issuing subsequent delivery orders against the contract as the need for the supply items arises (U.S. Army Health Facility Planning Agency [USAHFPA], 1999). The facilities Toolbox concept is similar in that requests for certain general or specific categories of work are bundled together into regionally or nationally negotiated contracts, and subsequent delivery orders against these contracts are the means by which facility managers actually execute individual projects. This process was designed to streamline the process by avoiding the traditional, separate, and interactive design/specifications, and construction[3] contracting actions (U.S. Army Medical Command [USAMEDCOM], 1997b).

There are currently 32 Toolbox contracts in place that cover a vast array of issues to include: nominal design; construction; repair; facility assessment; system inventory; electrical; heating, ventilation and air conditioning (HVAC); etc. These contracts cover 18 categories of facility management. The execution of these contracts is managed by three designated U.S. Army Corps of Engineers (USACE) District Offices and by the USAMEDCOM CCO. Each district’s Medical Support Team oversees these medically unique contracts and assists the FM in developing and executing delivery orders against them.

Each of the three district office’s method of pricing and awarding contracts is similar yet distinctly different in some key aspects from the other districts. Since FMs most often go through these district offices’ MSTs to access the Toolbox contracts (USAMEDCOM, 1998), this paper operationally defines these districts as <u>contracting vehicles</u>.

Toolbox contracting vehicle overview.

The first contracting vehicle is the USACE Fort Worth District Office that manages the Medical Job Order Contract (MEDJOC). The MEDJOCs are actually two separate Toolbox contracts that each cover half of the United States. They were designed to rapidly provide construction that required minimal design for major repair and minor construction projects. The MEDJOC vehicle's most unique feature is the fact that all prices for units of work are delineated in a unit price book (UPB) (Cassel & Gilday, 1997). Currently, the same contractor holds both MEDJOC contracts (USAMEDCOM, 1997b).

The second and third contracting vehicles are collectively termed Remediation and encompass a series of contracts managed by USACE's Mobile and Huntsville Districts. They differ primarily from the MEDJOCs in that they can include somewhat more-substantial (yet still considered nominal) design, and there is no UPB on which to base pricing. The two Remediation contracting vehicles--Mobile and Huntsville Districts--differ from each other primarily in that Mobile must issue a separate delivery order for design, and separate delivery order for construction for each project. Huntsville can issue a single delivery order for both the design and construction of a project. Both Remediation vehicles have several contractors to which they can issue delivery orders. They can allow these contractors to compete against each other, or choose one without allowing competition. Neither Remediation vehicle is required to solicit bids or proposals from outside this small pool of contractors. The remainder of the Toolbox contracts is managed by CCO, which is a USAMEDCOM office, not a USACE district. They are very specialized (e.g. personal services contracts, specialized medical infrastructure systems, etc.) and are not generally geared for general construction. Thus, they are not included in this study. A more detailed description of the salient features of each contracting vehicle will be discussed in a subsequent portion of this paper (see Discussion).

### Reasons to evaluate the toolbox contracting vehicles.

In the early 1990s, when USAMEDCOM began using the Toolbox concept, the physical condition of many MTFs posed the threat of losing accreditation from the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). Therefore, time was of the essence. Furthermore, most FM branches were still inexperienced and the FSP infrastructure provided a level of expertise that MTFs, in aggregate, did not have. In light of the above, USAMEDCOM was willing to “exchange money for time and expertise” and the Toolbox mechanism that it developed seemed appropriate at the time (J. M. Olson, personal communication, October, 1999). Facility managers have used these three contracting vehicles extensively to improve the physical condition of their MTFs. The Army Medical Department (AMEDD) spends approximately 35 million dollars each year in the Toolbox program (G. L. Christenson, personal communication, July, 2000) and now wishes to perform a more focused evaluation of these vehicles to determine if they should be reorganized into a system that better fits the needs of today’s Army MTFs in aggregate.

The USAMEDCOM Assistant Chief of Staff for Installation, Environmental and Facilities Management (ACSIE&FM) continually monitors these contracts via its quarterly Board of Directors/Contract Advisory Committee meeting attended by a quorum of USAMEDCOM’s regional facility directors (FD) and the USACE MSTs. Monitoring of such contracts consists primarily of discussions of individual projects at these meetings. Since no study has formally addressed the utility or cost effectiveness of these contracts, deciding which contracting vehicle to use to access the Toolbox for a particular project is based primarily on the intuition, past experience or “comfort-level” of the project manager.

The Toolbox program was developed for two main reasons. The first was to ensure that funds earmarked for facilities management and construction could be applied to actual projects before the end of the fiscal year. Military funds, in most cases, “expire” at the end of each fiscal year and must, therefore, be put into operation on the intended project (which the military terms “obligated”) before the end of the fiscal year. The timelines required for traditional contracting means often made obligating funds difficult. The second reason was to develop medically-unique contracts that could be employed easily, thus easing the burden on inexperienced or understaffed facility managers to develop contracts on their own for each project.

However, despite its intent to use Toolbox to quickly execute construction dollars, USAMEDCOM has placed a deliberately long-term process in the construction; master planning. USAMEDCOM coordinated with the U.S. Army Health Facility Planning Agency (USAHFPA) to develop facilities master plans for each MTF. USAMEDCOM is not currently questioning the Toolbox contracts used for most of the more specialized issues (e.g. medical gases, electrical testing, etc.). It does, however, question whether the Toolbox vehicles, namely MEDJOC and Remediation, which are designed to cover more general facility support projects, are being utilized by FMs to (either intentionally or unintentionally) circumvent the deliberately long-range master planning process (K. Whelan, personal communication, January, 2000).

In addition, USAMEDCOM questions whether FMs are using the vehicle that produces the results that are most important in a particular situation (e.g. if time is the most critical component of a particular project, is the FM using the vehicle that designs and constructs that particular type of project most quickly?). The researcher found no formal published study that investigated which vehicle produces (by any criteria or definition) the best quality, lowest expense or greatest expedience for a particular project scope. The fact that ACSIE&FM’s website description of projects eligible for each of the three vehicles is nearly identical (USAMEDCOM, 1999c) only adds to the potential for a facility manager to utilize a contracting vehicle that is not the wisest choice for a particular project.

Furthermore, discussions at the January 2000 quarterly meeting of the FDs and USACE MSTs indicated that USAMEDCOM is interested in examining the possibility of streamlining the structure of the MSTs. One method under consideration included reducing MST staffs, each of which follow the basic composition of a leader, several project engineers, a contracting officer, a procurement/payroll technician, and an administrative assistant (Horky, 1999). Another method considered was to eliminate two MSTs, leaving one to be the sole liaison between USAMEDCOM and USACE (USAMEDCOM, 1999d).

Because of these concerns, ACSIE&FM and the USAHFPA requested the assistance of this researcher in clarifying the differences between these three vehicles and attempting to determine if any is best-suited to a particular scope or type of construction or renovation project typically encountered in the AMEDD's capital improvement program. According to the commander of USAHFPA, the AMEDD threshold for capital improvement projects is 200,000 dollars and the maximum amount allowed is 10 million dollars (T. Kurmel, personal communication, February, 2000). Therefore, only projects within this dollar range will be used in this study. USAHFPA and ACSIE&FM further suggested that this evaluation could lay the foundation for future studies to determine if these three vehicles are still useful to USAMEDCOM in their current form.

Since these vehicles were not designed with performance metric comparability as a principle characteristic, there are a number of problems inherent in any analytical process with this goal. However, many of these are being examined by committees or offices within USAMEDCOM and require extensive research and data collection by teams of individuals. In addition, some issues, such as determining the overhead costs of MSTs, are confounded by the fact that MST members may work on other non-medical projects during lulls in medical project cycles. Currently data is either not available or accurate enough to consistently measure the medically-dedicated workload (USAMEDCOM, 2000).

## Statement of the Problem

All the potential problem statements alluded to in this paper lead toward two objectives. The short-term objective is to aid facility managers and directors in determining which contracting vehicle is best suited for a desired project. The long-term objective is to assist USAMEDCOM and USACE in shaping the overall contracting vehicle structure, arrangement, and mission.

## Literature Review

Several sources, as subsequent sections of this paper will show, attest that the general accounting principles and methodologies used in both military and government real property and construction management are inadequate. Metrics for cost, quality, and timeliness as they apply to this study are largely non-existent. Subsequent sections of this paper will discuss the reasons for this.

The experience of the researcher, literature review, and personal communications cited in subsequent sections of this paper will indicate that civilian private and municipal project managers supervise cost, quality and timeliness at the individual project level in much the same fashion as the government. However, though government’s construction programs are still far from being fully centralized, the civilian sector’s are much more fragmented in nature and, thus, do not include such systemic or region-wide analyses of projects as the government seeks to create for itself.

<u>Government-level metrics for repair and maintenance.</u>

The National Research Council has found that government processes are generally not properly structured to effectively account for the costs of facility maintenance and repair (National Research Council [NRC], 1998). Though that report refers specifically to repair and maintenance, one may infer that the same shortcomings exist in construction of federal facilities by reviewing the following statement:

> It is difficult, if not impossible, to determine how much money the federal government as a whole appropriates and spends for the maintenance and repair of federal facilities because definitions and calculations of facilities-related budget items, methodologies for developing budgets, and accounting and reporting systems for tracking maintenance and repair expenditures, vary. (p. 4)

Despite the continuing emphasis on cost containment within all areas of government responsibility, the same report states that government budgeting procedures, definitions and accounting had advanced little since 1990. A United States General Accounting Office (US GAO) report (US GAO, 2000) states that although efforts are continually being made to ensure the accuracy and availability of real property financial data, an effective systemic oversight mechanism does not exist. The same report emphasizes that up to date information about the general status of construction projects is not consistently maintained. Though these studies do not specifically discuss quality or timeliness metrics per se, the researcher infers that, at the government level, cost, quality and timeliness data for repair and maintenance issues are difficult to accurately and uniformly define, track and access.

Government-level metrics for construction.

At the more micro level, that is within the construction as opposed to repair and maintenance realm, the US GAO again echoed the above statements in saying that the General Services Administration (GSA) construction program lacked criteria for effectively measuring and evaluating cost growth in construction projects. It further stated that GSA’s general data on its construction projects was incomplete and inaccurate in that some costs were entered more than once, some not at all, and in one case, an entire project was missing from the database (US GAO, 1994a). An Air Force Institute of Technology study (Hoover, 1994) cited that quality is difficult to define in the construction industry and the standard quality improvement principles embraced by other industries have not taken root in construction. The researcher found no specific measures of timeliness and posits that construction cost, quality and timeliness data are also difficult to accurately and uniformly define, track and access at the government level.

<u>AMEDD-level construction metrics and data storage.</u>

<u>Existing cost information</u>

The personal communications and investigations of this researcher indicated that, at the AMEDD level, the same problems existed as at the government level. Definitions of construction costs varied depending upon the individual with whom the researcher spoke or the forum within which the researcher obtained the information.

For example, some USAMEDCOM and USACE personnel routinely calculated cost as actual construction cost only. Other individuals also included expenses for such services as contractor site visits and work plan development. Individuals wishing to include such site visit and work plan costs argue that such costs, in MEDJOC projects, become a “deposit toward construction” and should therefore be included (J. A. Khatena, personal communication, February, 2000). Opponents argue, however, that work plans are sometimes designed but never constructed. Similarly, in the case of Remediation contracts, several contractors may develop work plans, though only one work plan will be chosen for construction. However, the MTF will still pay for the other work plans that will not be executed.

Adding to the confusion are the USACE construction management supervision and administration (S&A) costs. S&A

costs are fees paid by an MTF or USAMEDCOM to USACE to oversee a project in the following categories: design/bid phase services; construction quality assurance (QA) activities; on-site project management; contract administration/management activities and; construction fiscal management activities. S&A costs are generally charged by USACE to the facility or project manager on a flat-rate basis (i.e. percent of construction contract cost). However, this rate is negotiable by project based upon the magnitude of S&A services required (USAMEDCOM, 1997a). For example, if a facility has a robust FM staff, it may not need USACE to perform all of the above services for a particular project. Thus, the S&A rate for that project would be lower than another project at the same MTF that may require greater technical expertise and therefore, a higher S&A rate. Also, one must consider that a well-staffed FM's savings from a lower S&A cost are actually paid for by the salaries and expenses of that particular FM staff and therefore are part of the true total cost of the project. Despite a negotiated S&A rate for each project, USAMEDCOM was still unclear how much overhead it pays for each project (USAMEDCOM, 2000), and expressed the need for more business-like cost accounting systems within the MSTs (USAMEDCOM, 1999d).

Another cost to be considered would be that of the salaries and operational expenses of the TAT. However, this could not be added to every project, for FMs often bypass the TAT and go directly to the MST with a project (M. A. Trudzinski, personal communication, October, 1999). Therefore, the researcher found no consistent or universally accepted metric for cost currently existing in the AMEDD facilities arena.

### Existing quality information

Finding existing metrics of quality presented an equally difficult situation, as did finding data on quality of construction projects. Before continuing, however, a brief description of relevant terms is necessary. Quality Control (QC) is the responsibility of the contractor. It is a plan to monitor quality and is written into the contract. Quality Assurance (QA) is the government's responsibility. It can be described as a sampling method to ensure that the contractor's QC plan is adequate and being followed (J. A. Khatena, personal communication, February 8, 2000).

In March 1999, USAMEDCOM directed that the government must perform all Quality Assurance Evaluations (QAE) because it viewed QAE to be inherently government in nature. This was due to the fact that with the closely-knit network of contractors involved in Toolbox contracts, the potential conflict of interest raised by contractor-performed QAE presented a material threat to USAMEDCOM's ability to maintain a professional and legal appearance (USAMEDCOM, 1999a). Despite this directive, USAMEDCOM has not been able to secure enough funding to perform a full verification of the contractors' QC efforts (G. L. East, personal communication, March, 2000; J. A. Khatena, personal communication, February, 2000). This funding shortfall exists even though certain QA activities are covered by the S&A fees paid to USACE (USAMEDCOM, 1997a). Therefore, fully complete QA does not exist in the AMEDD.

Secondly, QA reports in the AMEDD are in a narrative format. They focus on safety, contractor performance, and contractor adherence to specifications (R. B. Maynor, personal communication, January, 2000). Reports are filed on a regular basis. If, due to the aforementioned lack of funding, no government inspector actually performed a QAE during the period, a statement attesting to that fact is entered in to the report (M. P. Sartori & T. L. Walker, personal communication, February, 2000). Therefore, in aggregate, QAE reports will appear complete, regardless of the actual frequency of QA inspections. Truly defining quality would thus require the researcher to delve into each individual QAE report for every project in this study, which is beyond the scope of this research, especially since one of this paper's goals is to develop a tool for strategic level USAMEDCOM and USACE planners. Secondly, the current QA reports do not systemically indicate the severity of the quality control infraction (e.g. the time or money lost due to the QC problem, deviation from code compliance, cost to correct immediately, future costs if not corrected, impact on building safety, delay in completion, etc.).

The quality assurance woes of the AMEDD are not due entirely to lack of funding however. According to a study performed at the Air Force Institute of Technology (Hoover, 1994), quality in the construction industry in general is difficult to quantify and enforce. It claimed that many of today's efforts to continually manage or improve quality have met limited success in the construction industry. Among the major reasons are the lack of actual performance data, instability in the construction industry, and the inability to objectively evaluate potential contracting alternatives. This researcher, therefore, attempted to develop a proxy measure for actual QA data. That measure will be discussed in a subsequent section of this paper.

## Existing timeliness information

Several authors state that the streamlined process of job order contracting resulted in design and work being performed much faster than traditional contracting methods (Cassel & Gilday, 1997; Erickson & Murphy, 1994; McDermott, 1995; Moore & Stout, 1988). These studies did not include the empirical data, nor thoroughly define the variables that were used. The researcher found no studies comparing job order contracts to Remediation-type contracts in terms of timeliness. Thus, the literature review uncovered no specific metric to measure timeliness.

## Storage and availability of AMEDD construction data

This researcher’s investigation and literature review indicate that, like the federal government in general, the AMEDD has no central database designed to store project information. For the projects considered in this study, two branches of USAHFPA coordinate with the MSTs to ensure responsive contractor performance. These two branches, the Sustainment Branch and the Renewal Branch, each store data differently. The Sustainment Branch uses a proprietary database called ABSTAR, a Microsoft Access-based program, while the Renewal Branch uses its own ad hoc spreadsheet in Microsoft Excel. The information in these two databases is similar in that they both generally store the final non-stepped-down costs for the site survey, work plan and construction. However, they possess marked differences. Namely, Sustainment's contains each project's contract and delivery order numbers as well as the MST that managed it. ABSTAR also lists limited project update information. However, the database contains very limited descriptions of scope of work. Renewal's database contains no contract or delivery order numbers, and does not list the MST that managed the projects. However, it contains more detailed descriptions of scope of work, particularly if one uses the Renewal Branch web page (http://hfpa.otsg.amedd.army.mil/renewal.html) in conjunction. The website lists project updates, but not uniformly or consistently from project to project. Lack of a unified method of collection and storage of AMEDD data posed a great hindrance in comparing projects. Therefore, as noted above, neither operational definitions, uniform metrics, nor standard methods of collecting and storing data seem to exist across the AMEDD. This indicates that, in general, the AMEDD construction program has the same shortcomings in collection and storage of cost, quality and timeliness data, as does the government in both repair and maintenance and construction.

Purpose.

This study has two purposes. The first is to provide an overview of each of the three contracting vehicles. This overview is directed toward facility managers and directors in order to develop in them a general foundation of knowledge of the salient features of each contracting vehicle. This overview will be presented under the Discussion heading in this paper.

This foundation will aid the reader in understanding the second purpose of the study, which is the development and use of metrics to compare each contracting vehicle to the other two in terms of cost, quality, and timeliness for a variety of different types of medical construction projects. Since USAMEDCOM currently has no such systematic method of evaluation, its present system of data collection was not robust enough to fully support this endeavor.

## Development of cost metrics

The researcher considered the concept of programmed costs versus actual costs. The US GAO report concerning GSA’s construction management showed that many contract changes that contribute to cost growth are authorized by contracting officers to correct design and planning problems (US GAO, 1994a). Therefore, the researcher decided to use this concept to determine how closely each particular contracting vehicle stayed to originally programmed costs.

The US GAO report on military construction compared trends in planning and design costs as a percentage of the total project cost (US GAO, 1994b). This researcher combined this concept with that of the previously mentioned US GAO report (US GAO, 1994a) to compare projects via actual costs as a percentage of total programmed project costs. The researcher operationally defined this Percent Over/Under Budget.

Because of the lack of a standard operational definition of project cost, the researcher decided to use the non-stepped-down costs maintained by USAHFPA’s Renewal and Sustainment Branches. Some of these data are maintained in the branches’ databases, others are located only in each project’s individual file.

The first of these costs is Programmed Cost of Site Survey. This includes the planned cost of the site survey itself and any pre-work plan investigative work. Modifications to the cost of the site survey may be attributable to site conditions that were unforeseeable before the actual site survey. However, the researcher seldom encountered changes to this cost. Nonetheless, it is necessary to have such a metric in order to isolate cost increases or savings within each project. Therefore, this study operationally defined this metric as Actual Cost of Site Survey.

After the site survey comes the work plan. It is more likely that work plan costs may exceed their programmed amount than would site survey costs. Similar to the aforementioned, these costs are operationally defined as Programmed Cost of Work Plan and Actual Cost of Work Plan. Such increases can, of course, be partially the result of changes requested by the MTF. However, the researcher's experience leads him to believe that increases are due more to the haste or speed in the completion of the work plan, which the researcher believes is most likely attributable to the contract vehicle. The primary reason that this study identifies such costs is, again, to isolate cost increases within the entire project.

Finally, the study attempted to isolate from the entire project the Programmed Cost of Construction and the Actual Cost of Construction. This is where the majority of each project's total cost increases, if any, manifest themselves.

These operational definitions of cost were used to compare the project costs for each of the three contracting vehicles via a Basis of Comparison, which will be discussed and operationally defined in the following sections of this paper. The specific method in which these definitions of cost were combined to create cost metrics will be discussed in greater detail in the Method and Procedures section of this paper.

## Development of quality metrics

This study sought to quantify the quality of construction projects; the concept of which is elusive. The researcher previously established that, although the current QAE reports are a good source of qualitative information on AMEDD construction projects, their general narrative nature does not translate well into the quantitative needs of this particular study. Therefore, the researcher sought to develop a proxy metric for quality.

As the literature review revealed, correcting design and planning problems often contributes to cost-growth in government construction projects (US GAO, 1994a). Based on the individual experience of the researcher, these same modifications increase project timelines as well. The researcher posited that as the quality of the work plan increases, the cost and time attributed to modifications should decrease. Therefore, it was assumed that proxy measures for quality were cost and timeliness of the project.

This measure was not specific enough to compare the quality of an individual project to another, but taken together, the researcher hoped it would provide a reasonable measure to compare the quality of one contracting vehicle to another. This metric is rather implicit when compared to the other metrics of this study. The literature review, personal communications, and experience of the researcher indicate that other procedures could be developed to measure quality.

One method, as alluded earlier, would be for a team of experienced construction management personnel to perform a thorough analysis of each QAE report for each project. These personnel could then quantify the number of quality problems on each project and rate them, perhaps on a Likert scale, in terms of money or time lost in correcting the deficiency, degree to which applicable building codes were violated, etc.

Another method could be to have these same experts perform a detailed review of the contract modifications of each project, and categorize them (e.g. those to correct deficiencies in work plans, contractor deviation from specifications, workmanship, etc.). The number and dollar value of modifications could then be calculated as a percentage of total project cost, etc. to show which contracting vehicle performed the best per scope category (see Categorization of AMEDD Construction Projects below). A retrospective study could also examine the amount of repair or warranty work required in the facility within a specified time frame after project completion and make comparisons similar to those alluded to above.

None of this data is available in a database format and, as mentioned before, such data may require a team of technical experts to analyze. Therefore, such data collection and analysis was deemed by the researcher to be beyond the scope of this study, leaving him with only the implicit metric described in previous paragraphs of this section.

## Development of timeliness metrics

Since the research revealed no existing metrics for timeliness, the researcher developed one using several key milestones present in most projects. All of the projects to be used in this study are managed by two branches of USAHFPA, the Renewal Branch and the Sustainment Branch. The researcher consulted the chiefs of each of these branches, Mr. N. Chong and Mr. M. Sartori, respectively, in order to develop the metrics to measure timeliness.

The first of these is award of site survey. This is the date that the contractor was given permission to begin thorough examination of the site in order to develop a work plan (N. Chong & K. Jones, personal communication, February, 2000). Depending upon the nature of the project, a separate site survey may not be included in the project. Thus, for this study, the award of site survey and notice to proceed (NTP) for the work plan were considered synonymous. These terms were operationally defined in this study as Date of Award of Site Survey.

The second milestone used was the date of the final approval of the contractor's completed work plan. The time taken is primarily a reflection of the contractor or the contracting vehicle, not the approval process itself (N. Chong & K. Jones, personal communication, February, 2000). This term was operationally defined in this study as Date of Approved Work Plan.

The next milestone was operationally defined as the Date of Construction Award. This is the date in which the contractor is given notice to proceed in making the preparations to begin construction. The interval between date of approved work plan and this date is largely contingent upon the timing of the commitment of funds, not the contracting vehicle or contractor (N. Chong & K. Jones, personal communication, February, 2000). Thus, that interval is not included in this study.

The final milestones relate to substantial construction completion. Beneficial Occupancy Date (BOD) is a commonly used term in the construction industry, but it is not tracked as such either by the Renewal or Sustainment Branches. It describes a point in the project when construction is not fully complete, yet when the occupant may use the structure for its intended purpose. According to Mr. Sartori and Major Walker, this equates to 85% of project completion. Percentage of completion is a standard metric in the construction industry used extensively for determining payment to contractors. Both the Renewal and Sustainment Branches measure this, although such information may only be contained in actual project data and not in a database per se. Mr. Sartori suggested 85% completion as opposed to 100% because often the final 15% consumes a much greater amount of time than any other 15% increment in construction. This is usually due to minor discrepancies or disagreements over the contract specifications between the contractor and USACE or USAMEDCOM, and not problems with the contractor or contracting vehicle itself. Therefore, the time required from the start of construction until 85% completion is a better gauge for measuring the performance of the contracting vehicle than that of start of construction until 100% completion (M. P. Sartori & T. L. Walker, personal communication, February, 2000). Therefore, the date on which the 85% milestone was programmed, and the date it was actually reached are operationally defined as Programmed 85% Completion Date and Actual 85% Completion Date, respectively.

In developing a timeliness metric, the researcher applied the concept employed by the US GAO in evaluating planning and design costs as a percentage of total project cost (US GAO, 1994b). The researcher applied this concept to create a metric for timeliness by expressing actual time required by the contractor as a percentage of time programmed on the original schedule. This metric is operationally defined as Percent Late/Early. It compared both the programmed/actual times from date of construction award until date of 85% completion, as well as the time from date of award of site survey until 85% completion (less time between date of approved work plan and date of construction award). The specific method in which these functions of timeliness were combined to create a timeliness metric will be discussed in greater detail in the Method and Procedures section of this paper.

Categorization of AMEDD construction projects

The projects managed by the three MSTs in coordination with the Sustainment and Renewal Branches of the USAHFPA vary tremendously in scope. According to Mr. Mike Sartori and Major Troy Walker of the USAHFPA Sustainment Branch, their branch manages projects that primarily deal with repair and replacement of components within a building such as the HVAC, fire sprinkler system, electrical distribution system, chillers, etc., and rarely engages in projects that involve a redesign of floor plan, patient flow, etc. Conversely, the Renewal Branch primarily manages projects that involve a redesign of floor plan, patient flow, or even overarching function of a building. Sartori and Walker operationally defined the latter as Functional projects, and those involving only the repair or replacement of major building components as Infrastructure (M. P. Sartori & T. L. Walker, personal communication, February, 2000; USAMEDCOM, 1999b). The researcher decided to use these operational definitions as the first step in developing a basis of comparison among projects.

Secondly, the previously mentioned US GAO report on military construction (US GAO, 1994b) compared projects based upon project type. That particular study grouped all medically related projects together as one type (US GAO, 1994b). This categorization of buildings is similar to the method used by Army Regulation 415-28 to group all medically related buildings into one main class. Department of the Army Pamphlet 415-28 further subdivides this class into four category codes: medical center or hospital; medical laboratories (which includes such diverse spaces as pharmacy, morgue, veterinary, warehouse and patient family guest house); dental clinics and; dispensaries or clinics (Department of the Army, 1996b; Department of the Army, 2000). However, based on the experience of this researcher and current FM personnel (C. R. Snodgrass, personal communication, March 16, 2000), significant dissimilarities exist within the medical category that may impact costs. For example, the costs required to facilitate the exacting design and construction of a medical operating room far exceed those of designing and constructing clinic administration space.

USAMEDCOM developed a funding priority matrix that further divided the general medical category into three subcategories. The first of these is medical and dental operations, which the matrix defines as space where patient care is conducted. The second is research, veterinary and medical support, which includes spaces for research and veterinary activities, and ancillary support areas such as pathology, pharmacy, nutrition care, etc. The final category of the matrix is administration and support which includes areas such as waiting rooms, corridors, rest rooms, warehouses, etc. that provide indirect support to operational and support areas (USAMEDCOM, 1999b).

The experience of the researcher as a former facility manager, and the personal communications with FM personnel at Darnall Army Community Hospital (DACH) at Fort Hood, Texas, led the researcher to believe that this study required a more detailed categorization (C. R. Snodgrass, personal communication, March 16, 2000). The potential for significantly differing levels of design detail, materials, and construction methods within those three categories was too great. The National Research Council study (NRC, 1998), though it referred specifically to repair and maintenance projects, corroborates this concern:

> Determining if expenditures of maintenance and repair resources are effective is a difficult undertaking. The issue goes beyond the total dollars spent because the amount of money and resources allocated to maintenance and repair does not indicate whether those

> resources were used to repair mission-critical systems or to remove snow. (p. 30-31)

However, the USAMEDCOM matrix above was designed to prioritize funding for projects, not to group them based upon scope. Thus, another metric needed to be found for this study that could segregate projects based on scope, and determine the effectiveness of the time and money spent for each. However, the same National Research Council study (NRC, 1998) stated that, for repair and maintenance projects, such a metric does not exist:

> Because government agencies do not consistently track maintenance and repair expenditures, it is difficult to develop measures to determine how effectively funds are being spent either, within or across, agencies. (For example, one measure might be total maintenance dollars spent per square foot of administrative space.) Without consistent measures, it is very difficult for facilities program managers to determine whether their maintenance and repair resources are being used optimally across their facilities inventory. Without objective benchmarks (points of reference from which measurements of any sort may be made) by which to identify “best practices” among the agencies, information that could be shared and used

> across agencies to improve government performance in this area is not available. (p. 31)

Though the NRC study again speaks specifically about repair and maintenance, the researcher already established that many of the same data accountability issues exist in the construction realm. Though the above mentioned sources lay the foundation for addressing differences in scope for functional projects, they do not address the concept of infrastructure projects at all. Therefore, from the NRC study and lack of ability to find such a metric elsewhere, the researcher posits that such a metric does not exist in the medical construction realm. Thus, the researcher would have to develop such a comparison tool.

## Developing bases of comparison

Mr. G. R. Hodges and Mr. C. R. Snodgrass from the FM branch at DACH contributed their professional opinion to assist the researcher in developing bases of comparison to group projects according to scope of work and equitably compare them, though their magnitudes may differ greatly. Ideally, these bases of comparison would allow the researcher to evaluate projects from different MSTs and contractors, such that they could be compared in terms of cost, quality and timeliness.

As mentioned before, the first step in developing the basis of comparison metric was to develop operational definition for functional area projects, and the same for infrastructure system projects. The researcher used the definitions provided by Sartori and Walker. Next, both of these needed to be divided into scope categories similar enough that costs, quality and timeliness could be equitably compared within them. The researcher enlisted the assistance of Mr. Snodgrass and Mr. Hodges in this endeavor.

Referencing the projects available in the functional category, Mr. Snodgrass, Mr. Hodges and the researcher (heretofore referred to as “the team”), developed six scope categories based upon unique construction or materials required. These categories are: veterinary clinics (new construction); general clinics (renovation); dental clinics (renovation); inpatient areas (renovation); administrative areas (renovation) and; specialized areas (renovation). The specialized areas category was broken down into laboratory, radiology, computer rooms, and maintenance/repair shops. Administrative areas referred to spaces where the majority of space was designated for administrative purposes only. Such areas may include medical warehouses, an administrative wing of an MTF, etc.

The administrative spaces normally part of veterinary, clinic, dental, inpatient and specialized areas were considered as part of those areas and not listed as administrative areas. The exception to this was if the administrative space for a project in one of the above-mentioned areas constituted a majority of the space. In such a case, the project would be considered broken into the two appropriate categories.

The final step in developing a basis of comparison for functional projects was to determine a unit of measure for each scope category. For each, the team decided the most appropriate unit was gross square footage (GSF). This paper operationally defines GSF as the total square footage within the boundaries of a project area, including spaces occupied by wall thickness, mechanical rooms, etc. The final basis of comparison for functional projects is shown in Table 1.

Due to the vast array of infrastructure systems within modern MTFs, the number of potential scope categories could be, perhaps, greater than 20. Therefore, only those infrastructure systems likely to be included in Toolbox projects were considered. Within the infrastructure category, the team developed 11 scope categories based, again, upon unique construction/materials required. Some of these categories were further divided based upon other factors. These factors and the units of measure for each infrastructure system scope category are listed in Table 2. The method by which the bases of comparison relate to the metrics for cost and timeliness are discussed in the Method and Procedures portion of this paper.

## Method and Procedures

The first step in this process is to provide succinct and clear descriptions of each of the three contracting vehicle's salient features. As noted in the personal communications of the researcher (J. Watts, personal communication, May, 1999), the differences between each of the three contracting vehicles is not readily understood by many facility managers (J. M. Olson, personal communication, August, 1999), nor is such information readily available to these individuals (J. Watts, personal communication, August, 1999). A concise review of these salient features will be the first step in assisting those in both the MTF level and the USAMEDCOM and USACE level positions to make more business-like decisions.

The second step is to evaluate a series of projects executed via each of the contracting vehicles in terms of cost, quality and timeliness. Ideally, at the MTF level, this would steer the facility manager toward choosing the contracting vehicle best suited for a specific project or fiscal situation. At the USAMEDCOM and USACE level, this would guide planners in creating the most streamlined MST/USACE/USAMEDCOM contracting structure and process.

Retrieving Data: Categorization

The researcher coordinated with USAHFPA Renewal and Sustainment Branches to access the databases mentioned in previous sections of this paper. The Sustainment Branch's database contained information on 2,800 projects. Based on the instructions of the researcher, Major Walker of the Sustainment Branch eliminated all projects in the database that were: less than 200,000 dollars and greater than 10 million dollars; less than 85% complete; or completed by any other method than one of the three contracting vehicles considered in this study. Doing so reduced the number of potential projects to 113, which were then segregated into functional and infrastructure categories, based on the limited description of the project scope contained in the ABSTAR database. This left the researcher with 25 functional projects and 88 infrastructure projects.

The researcher applied the same filters to the Renewal Branch database, reducing the number of projects from 52 to seven (four functional and three infrastructure). Thus, from both databases, there remained at that point, 29 functional and 91 infrastructure projects.

Finally, using the bases of comparison, the researcher, discarded any projects that did not have a project similar in scope performed by at least one other contracting vehicle. For example, two projects nearly identical in scope would be eliminated if the same contracting vehicle executed them both and no other contracting vehicle executed a project similar enough in scope. The reason, in that instance, is that neither project provided any value in comparing contracting vehicles for that scope category. Also eliminated were any projects that did not fit one of the categories of scope. For instance, a project to renovate the radiology, housekeeping, and DPW maintenance shop areas of a facility was eliminated because, though functional in nature, it did not fit into any single functional scope category. Any project whose description was too vague to appropriately place into one of the basis of comparison subcategories was also eliminated. Such criteria for exclusion left the study with 24 functional projects and 45 infrastructure projects. Tables 3 and 4, respectively, show the number of functional and infrastructure projects per basis of comparison subcategory and MST.

The researcher based the above categorization on the information contained in the Renewal and Sustainment Branches’ databases. In these databases, descriptions of the scope of projects were often rather vague. Thus, the researcher requested from each branch a summary of each project’s statement of work. This was intended to enable the researcher to accurately place projects in their respective scope categories. For example, a project to replace a chiller may purely require replacing a chiller with nominal associated work. Another project to replace a chiller, however, may include asbestos abatement, tearing up 2,000 square feet of the parking lot to replace supply lines, tearing down 40 linear feet of external wall, etc. Therefore, the two chiller replacement projects are not really comparable. A brief description of all the components of the project greatly enhanced the researcher’s ability to determine which projects could truly be compared to others.

The researcher obtained summarized statement of work descriptions for seven of the 69 projects under consideration from Mr. Chong and Ms. Jones of the Renewal Branch, and from that branch’s web page. For the remainder, the researcher coordinated with the TAT office in Georgia, through Major Walker in Texas. However, for approximately 25% of the projects, the documents from the TAT office did not contain enough information. Thus, the researcher attempted to coordinate with points of contact at each facility. The result of these efforts was the collection of statement of work data for 65 of the 69 projects under consideration.

The four projects for which no statement of work data was collected were eliminated from direct comparison with other projects within scope categories. At this point in the study, however, the researcher realized that the potential for collecting only incomplete data was seriously threatening the entire study. Therefore, the researcher decided that if a project's documentation contained the required costing data, it would be used to calculate aggregate comparisons in overall, infrastructure, and functional categories in the areas of average cost—percentage over (overall and per MST), and average cost per project (overall and per MST). This concept is illustrated in Tables 7 and 8. Projects previously eliminated from consideration because there was no similar project from another MST to which to compare them, were not reintroduced to the study.

The team carefully reviewed the summarized statements of work and cost data from each of the projects. Seven were deemed too dissimilar from the other projects in their respective scope categories for direct comparison and were handled in the manner shown in Tables 7, 8 and 9 and described above. Tables 5 and 6 illustrate how the original grouping in Tables 3 and 4 had to be modified.

The team discovered that seven infrastructure projects were accomplished via a collaboration of two or more MSTs (i.e. one MST was responsible for the work plan, and another was responsible for construction, etc.). This prohibited comparison of MST cost, timeliness and quality. Therefore, the researcher created a “quasi fourth MST” called Combination. Projects that fell into this category were only used to aid in developing baseline comparison information within each scope category, not to make direct MST comparisons per se.

The elimination or re-categorization of projects left four scope categories with an inadequate array of projects to facilitate comparisons between MSTs. The researcher kept these in the study and included them in the aggregate data within each of these scope categories to be used by other researchers for future studies. All the necessary changes to Tables 3 and 4 are presented in Tables 5 and 6, respectively.

Retrieving Data: Calculations

As discussed in a previous portion of this paper, neither the Sustainment nor Renewal Branches' databases contained enough specific data for any meaningful calculations of project cost or timeliness. Therefore, the researcher developed a spreadsheet and sent it to the Sustainment and Renewal Branches. The Renewal Branch attempted to provide the requested data, as available, directly to the researcher. The Sustainment Branch queried the TAT team members who had regional responsibility for project execution. Via this spreadsheet, the researcher requested the following data elements for each of the remaining projects:

1. Programmed Cost of Site Survey
2. Actual Cost of Site Survey
3. Programmed Cost of Work Plan
4. Actual Cost of Work Plan
5. Programmed Cost of Construction
6. Actual Cost of Construction
7. Date of Award of Site Survey
8. Date of Approved Work Plan
9. Date of Construction Award
10. Programmed 85% Completion Date
11. Actual 85% Completion Date

As in the quest for statement of work summaries, the researcher had to coordinate directly with individual MTFs to attempt to obtain cost and timeliness data for approximately 25% of the projects in the study.

## Calculations and Analysis

### Cost.

Data from each of the six cost-related elements above were entered, if available, into the spreadsheet for each project. If no costs were given for site visit or work plan, the researcher entered none into the spreadsheet. The researcher assumed that if no cost increase were specifically given for cost of site visit, work plan, or construction, none was entered. If, in such cases, however, the total cost given exceeded the sum of the given site visit, work plan and construction costs, the delta was added to the construction cost.

The spreadsheet calculated five cost metrics for each project: site visit cost—percent over/under budget; work plan cost—percent over/under budget; construction cost—percent over/under budget; total project cost—percent over/under budget; and cost per unit of measure. The spreadsheet calculated percent over/under budget in the following manner:

$$\frac{\text{(actual cost – programmed cost)}}{\text{programmed cost}}$$

Cost per unit of measure was calculated as:

$$\frac{\text{actual total project cost}}{\text{unit of measure}}$$

Some projects were a combination of more than one unit of measure. For example, a fire sprinkler project may have involved repair/replacement of existing sprinklers, as well as installing sprinklers in a large unsprinkled area. In such cases, the researcher had planned to calculate percent over/under budget and cost per unit of measure using a hybrid method based on available data. For instance, data analysis may have shown that Mobile performed sprinkler repair/replacement at an average (for projects A, B, and C) of x dollars per GSF and new sprinkler installation (for projects D, E, and F) at y dollars per GSF. If the above project (project G) were 40 percent sprinkler repair/replacement, and 60 percent new sprinkler installation, the total cost could be multiplied by 0.40 and 0.60 to determine the respective costs for each unit of measure. The cost of the sprinkler repair/replace portion of project G could be compared with the x dollar per GSF cost of projects A, B, and C. If it were similar, it could be added to the total to continue to compute averages in the following manner:

$$\text{Sprinkler Replace/Repair} = \frac{\text{Cost of A + B + C + (G X 0.40)}}{\text{GSF of A + B + C + (G X 0.40)}}$$

However, costs for these projects were too interrelated to delineate them via this simple multiplication method. Furthermore, costing data and percentage of new areas versus repair of existing ones was seldom available. Such data could not be obtained without a detailed analysis of the particular project. Therefore, whether or not to include or exclude such projects was the decision of the team, based as objectively as possible, on the cost and project description data when analyzed. Projects chosen for inclusion in the study were then compared to others irrespective of percentage of new areas or repair of existing ones.

Total costs were summed and divided by the sum of the units of measure to determine the average cost per unit of measure for each applicable contracting vehicle in each scope category. These results are shown in Tables 7 and 8. The researcher then calculated the average of each of the percent over/under budget metrics listed above for overall (infrastructure and functional projects combined), infrastructure, and functional categories. Results are listed in Table 9.

Timeliness.

The researcher planned to enter data from each of the five time-related elements above into the spreadsheet for each project. The spreadsheet would calculate three timeliness metrics for each project: total work plan time; construction—percent late/early; and total project—percent late/early. The spreadsheet would calculate total work plan time (expressed in days) in the following manner:

(date of approved work plan – date of award of site survey)

Construction—percent late/early was calculated as:

$$\frac{(\text{Actual 85\% Completion Date} - \text{Date of Construction Award}) - (\text{Programmed 85\% Completion Date} - \text{Date of Construction Award})}{(\text{Programmed 85\% Completion Date} - \text{Date of Construction Award})}$$

Total project—percent late/early was calculated as:

$$\frac{\text{((total work plan time) + (Actual 85\% Completion Date - Date of Construction Award))}}{\text{((Programmed 85\% Completion Date - Date of Construction Award) + (total work plan time))}}$$

The researcher planned to determine total project time—percent late/early for each applicable contracting vehicle in each scope category. However, only one (a Fort Worth project) of the 69 project data sets contained enough timeliness information to calculate all three timeliness metrics. Five others (four Huntsville and one Fort Worth) contained only enough data to calculate construction—percent late/early. These five projects were located in three scope categories, so no valuable assessment of time could be determined.

Quality.

As discussed previously, no solid metric exists to measure quality, and the data necessary to develop such a variable lie outside the scope of this study. The researcher posits, as outlined in a previous section of this paper, that projects finishing ahead of schedule possessed a better quality work plan than those that finished behind schedule. As indicated in a previous section, however, even partial timeliness data was available for only 7% of the projects in the study. Another study (US GAO, 1994b) demonstrated that poor designs result in increased construction costs and modifications. Cost data was available for all projects in the study, and information on the number of modifications was available for 61 of the 69 projects.

The researcher obtained modification data from the ABSTAR database (the Renewal Branch database contained no modification data). In this researcher's opinion, the database's information on modifications was limited and unreliable. ABSTAR sometimes contained a cost and description for the modification, sometimes one or the other, and sometimes neither. Descriptions of modifications, if included, usually only contained vague statements such as, "Scope of work modified." In only one project did the number of modifications exceed three. The experience of this researcher, and magnitude of cost increases in some projects, indicated that the number of modifications listed in ABSTAR is inaccurate in that it is unrealistically low. This leads the researcher to believe that the database administrator filtered or grouped modifications based on the fact that the number and descriptions of all modifications for all 2800 projects in the database are too voluminous to list individually. The administrator's criteria remain unknown to the researcher. In many cases, ABSTAR listed events such as the decision to implement the work plan, or increase of project cost to include construction, etc., as modifications. The researcher reviewed available information on every modification and attempted to include only those modifications that were true alterations to the programmed scope or cost, or both. The researcher thus decided that modification data was neither valid nor reliable and could not be used in this particular study. Table 13 shows the average number of modifications per project, but this information is provided only to aid future researchers.

Based upon the lack of timeliness data, the researcher had to modify his metric for quality. The researcher had posited that MSTs with the greatest budget overruns, or whose projects contain the greatest number of modifications, or both, produce lesser quality work plans or construction than those that finish under budget or with fewer modifications. Though modification data will not be used, the researcher posits that deviations from planned costs may indicate the degree to which the plan was flawed. Therefore, in the absence of other data elements, the researcher suggests that adherence to programmed costs may be a proxy for a quality metric.

Reliability and Validity

In terms of reliability, one must determine how it applies to the four groups of data elements needed for this study: cost; timeliness; quality; and modifications. Since the cost and timeliness data elements are derived from established milestones present in any construction project, any researcher using this tool given the same projects from which to choose would produce the same results. Though the data was collected from two different databases, the data required for cost and timeliness, if available, would possess good reliability. However, in terms of equivalence, different researchers may choose to manipulate data for some of the aforementioned hybrid projects differently when entering them into the spreadsheet. Nonetheless, for cost and timeliness, the data and the formulae for calculating them would remain consistent from researcher to researcher.

As mentioned earlier for data on quality, the QAE reports are completed with differing frequencies at different projects, are not as complete as USAMEDCOM desires, and are quite subjective. Thus, even if they were available, data on quality would be unreliable.

Because of lack of reliable data on quality, the researcher sought out data on modifications. Unfortunately, the modification data are unreliable as well. As discussed earlier, only the ABSTAR database contained modification data and such data seemed to have been screened by the database administrator using unknown criteria. Furthermore, the data did not contain sufficient narrative information for the researcher to determine if it should be included in the study. Therefore, despite availability, modification data were not used in this study.

The validity of this study is probably best determined by examining the content validity, that is, the degree to which the data elements and metrics represent MST performance, and how well the data represents the universe of all Toolbox projects. Based on the experience of the researcher as a former medical facility manager, cost, quality and timeliness are the most-critical factors in the eyes of the tripartite design and construction team--the owner (USAMEDCOM), the architect/engineer (USACE/contracting vehicle), and the contractor. Therefore, the concept of using cost, quality and timeliness formed a solid basis for the validity of the metrics. The researcher attempted to strengthen the content validity of the metrics by having subject matter experts (namely the aforementioned team) assist in developing the measurement tools (i.e. the bases of comparison and the units of measure). These same experts contributed to the content validity of the data by determining which projects fit into each scope category and determining if projects within each category were comparable.

The milestones used do develop the cost and timeliness metrics are standard throughout the construction industry. Continually comparing a project’s true costs and timelines to those of a budget and schedule is, again, a common practice in the industry. Thus, the metrics themselves for cost and timeliness are solid, despite the non-availability of timeliness data. Nonetheless, the general validity of cost and timeliness metrics is favorable. However, since the researcher was unable to obtain a significant amount of data on timeliness, it was not used (see the Results section of this paper). Though it was not ultimately used in this study, the metrics for timeliness should serve as a tool for future researchers and as a subject for routine internal review and audits.

In this study, the metric for quality migrated from a quantification of QAE reports to a subjective proxy measure composed of cost and timeliness data. As mentioned earlier, timeliness data was unavailable so the quality of each MST for each scope category is purely the educated judgement of the researcher (see also Results). This obviously lowers the content validity, the degree to which will likely be determined only if more data becomes available.

Costs per square foot serve as a basic planning tool for general budget planning in the construction industry. However, if the literature review is any indication, many of the other units of measure developed in this study are not commonly used. Therefore, validity for those uncommon units of measure is difficult to determine.

The Results section of this paper discusses the fact that variance and low n-values lessen the statistical significance of the only data available: cost data.

## Results

Some of the most significant results of this study were not based upon cost, quality and timeliness data, per se, but rather on the lack of such data in the system. Therefore, some of these results have already been discussed in previous sections of this paper. The majority of the results of this study are best illustrated in tabular format (see List of Tables on page 6 of this paper). The researcher will interpret, as appropriate, the results in the Discussion section of this paper.

Though the study began with approximately 2,800 projects, the aforementioned selection and grouping criteria, along with the paucity of project data, often reduced the number of projects in each scope category to single digits. In several cases, two or three projects from a single contracting vehicle are the only representatives for particular scope categories. Timeliness data robust enough to compute any of the desired timeliness information existed in only six of the 69 projects and, therefore, will not be shown in tabular format or used to evaluate any MST. Nonetheless, the available data did allow the researcher to draw some preliminary conclusions and make recommendations for future study. The results are shown in Tables 7 through 12, and will be discussed in the second part of the Discussion section of this paper.

## Discussion

The Discussion section of this study contains two parts. The first is an overview of the salient characteristics of the three contracting vehicles. The second portion is a discussion of the results of the cost, timeliness, quality analyses in the study.

## Overview of Contracting Vehicle Characteristics

As mentioned in previous sections of this paper, a succinct description of the three contracting vehicles will aid facility managers, facility directors, and strategic planners in making wise decisions. In the interest of brevity, the researcher attempted to not repeat in detail the concepts discussed in earlier sections of this paper. This section will first describe the characteristics common to all three contracting vehicles, then discuss their dissimilarities. Each subsection will discuss advantages and disadvantages as appropriate. A tabular overview of the most significant salient characteristics is contained in Table 14.

### Similarities.

#### Indefinite Delivery/Indefinite Quantity (IDIQ)

According to Gary East, who manages the Huntsville MST, each of the contracting vehicles utilizes IDIQ contracts. Simply stated, indefinite delivery means that the government has no specific date when the services will be performed, except that they must occur within the performance period of the contract. Indefinite quantity implies that the government does not know how much of the general type of service it will require during the performance period. Both terms combined indicate that the government does not specifically know how much of or when it will need the service (G. L. East, personal communication, March, 2000). Contracts are awarded for a contract period followed by several option years. During such times, each contractor is guaranteed a minimum amount of work. Conversely, a maximum amount of work also applies to the contract. The IDIQ concept gives contracting officers and facility managers great flexibility.

Blanket Purchase Agreement (BPA) or “bundled” concept

The basic framework of each contracting vehicle is built around the BPA concept described earlier in this paper. The practice combines many contracts into one administered by a single contract team (Erickson & Murphy, 1994). In the case of MEDCOM, the team is actually a combination of the TAT and MST. Combining contracts is often referred to as bundling and some argue that it is unfair to small contractors who cannot possibly bid on a national contract (Worsham, 1997). Others, however, claim that the practice actually increases the opportunities for small contractors. According to Erickson and Murphy, “Firms that can’t [sic] compete for larger construction contracts can provide the services or supplies required by individual job orders” (Erickson & Murphy, 1994, p. 70). The latter concept affords advantages to small or disadvantaged contractors in that they are freed from the burden of bonding and other government requirements, which must be borne by the prime contractor (Cassel & Gilday, 1997). Though bundling no doubt eliminates many from consideration as the prime contractor, military JOCs in many cases offer a distinct advantage over civilian contracts. Nonmilitary organizations may require prime contractors to post a bond for 75% of the contract maximum, while in military JOCs, contractors may be required to submit bonds for a lower percentage of only the contract minimum (Cassel & Gilday, 1997).

## Competitive bid

For each contracting vehicle, contracts are competitively bid. That is, for each set of bundled contracts, the statement of work, bidding schedule and contract clauses are announced in the Commerce Business Daily or similar solicitation forum. A board evaluates contractor bids based upon cost and the contractor’s technical expertise and past performance (G. L. East, personal communication, March, 2000). The subtle differences between the bidding processes of the three contracting vehicles will be discussed in greater detail in later sections.

Burman has described the practice of bidding for bundled contracts with established minimums and maximums as competing for an “empty basket” (Burman, 1997a). Rather than initiating separate contracts and contracting actions for each project, projects are accomplished via task or delivery orders that are placed into this figuratively pre-negotiated basket. This comprises the heart of the streamlined procurement process. Some, however, argue that, as technology advances the state of the art for a given product or service, contractors may lose money if they cannot raise their prices accordingly (D. K. Taft, 1995). In the opinion of the researcher, this argument applies more to MEDJOC contractors than Remediation contractors, because of the MEDJOC Unit Price Book (UPB). Later sections of this paper will enlighten the reader on the UPB concept.

<u>Work plans, not designs</u>

Another similarity is that none of the three can develop designs and specifications; they can only develop work plans. Under traditional contracting methods, design drawings and specifications must be able to “stand alone,” such that the construction contractor (who most likely has no institutional knowledge of the project) can build the project based solely on those drawings and specifications.

An architect/engineer (A/E) firm usually accomplishes such work and such services are forbidden in JOCs by the Federal Acquisition Regulation (FAR) (Department of the Army, 1996a). Conversely, work plans usually consist of single line sketches (G. L. East, personal communication, March 2000) accompanied by standard plans and specifications that have been adapted to actual site conditions (Cassel & Gilday, 1997). A work plan is a working drawing that cannot be easily transferred between contractors and would not be appropriate for bidding work in the construction community without substantial involvement of the contractor who developed it (G. L. East, personal communication, March 2000). Development of design and specification documents obviously requires a great deal of time and money. USACE designed the Toolbox concept to reduce pre-construction timelines and costs (for less-complex projects) by eliminating the need for such separate design, specification, and construction contracting actions (Cassel & Gilday, 1997).

Work plans are successful in the MEDJOC/Remediation program because, under Fort Worth’s MEDJOC, the same contractor who developed the work plan is the same one who performs the construction. In the case of Huntsville and Mobile’s Remediations, the contractor who performs the construction may be the same one who developed the work plan, or may be another chosen from a small "pool" of Remediation contractors with whom the Mobile MST works often. Thus, the time saved is a result of not only the elimination of several separate contracting actions for one project, but also the elimination of many of the formal drawings and detailed specifications necessary for traditional contracting (Moore & Stout, 1988).

USAMEDCOM, or the MTF who requests it, pays for the cost of developing a work plan. If the work plan never goes to construction, the contractor keeps the money. However, under the MEDJOC program, if the project is built, work plan costs become a "deposit towards construction" (J. A. Khatena, personal communication, February, 2000). Work plan costs under either Remediation program are separate costs and are not applied toward construction.

This system enables the facility manager to effectively manage year-end funds in that he or she can develop work plans and "shelve" them until construction funds are available (often short notice near the end of the fiscal year) (Cassel & Gilday, 1997). Facility managers must be careful how long a project is shelved, for Mr. East of Huntsville estimates it costs between 5,000 and 10,000 dollars to revitalize a work plan that has been shelved for more than a year (G. L. East, personal communication, January, 2000).

This flexibility has its drawbacks though. Speculation within ACSIE&FM and USAHFPA asserts that some work plans are developed by facility managers merely to appease an MTF commander or department. The facility manager, for valid reasons, considers the construction a bad idea, and the work plan is shelved until the commander or department chief transfers to another facility.

Improved time, quality & cost

Several referenced sources (Cassel & Gilday, 1997; Erickson & Murphy, 1994; McDermott, 1995; Moore & Stout, 1988) agree that the streamlined job order contract (JOC) procurement process is faster than the individually bid project process (the researcher assumes the same is true for the Remediation contracting process). The same sources also agree that the same process produces higher quality than on individually bid projects. Reasons cited are improved interaction between the government and the contractor, as well as the fact that the government bears no obligation to award work beyond the contract minimum if contractor performance is unsatisfactory (Cassel & Gilday, 1997). In the case of Remediation, if the MST is not pleased with one of its contractors, it can award subsequent orders to its other contractors. In the larger sense, facility managers hold the same leverage over each of the three MST contracting vehicles.

Erickson and Murphy claim that, for the city of Chicago, the JOC method in particular produces overall construction costs 8.6% lower than the city’s in-house estimates. They further state that the process produces costs significantly lower than individually bid projects (Erickson & Murphy, 1994). However, the intrinsic concept of a single project management team can strain the resources of an organization (McDermott, 1995). Cassel and Gilday’s study of Army JOCs indicated that increased contract administration functions deplete whatever direct cost savings the process may have achieved (though they believe that no direct cost savings in labor, materials, etc. are actually recognized) (Cassel & Gilday, 1997). As discussed earlier, USAMEDCOM is currently examining the size and costs of the TAT/MST contract administration team. Further complicating USAMEDCOM’s decision is the fact that some facility managers are either familiar enough with the Toolbox process, or have a robust enough staff, that they bypass the TAT and coordinate directly with the MST (M. A. Trudzinski, personal communication, October, 1999).

Dissimilarities.

The differences between the three contracting vehicles are in some ways easily distinguished, and in other ways rather subtle. The three main differences relate to the pricing and negotiation of work, selection of prime contractors, and the flexibility each vehicle has with its prime contractor(s).

Pricing and negotiation of work

MEDJOC

The maximum for a single delivery order using the Fort Worth MEDJOC contracting vehicle is 300,000 dollars. This limit can be raised to 2 million dollars with a waiver from the garrison commander or higher (Department of the Army, 1996a). All Fort Worth MEDJOC pricing is based on the unit price book. The standard Army non-medical UPB is a list of approximately 50,000 individual construction tasks with an accompanying price per task unit. For instance, a UPB line item might be one linear foot of non-load bearing internal drywall. The UPB prices incorporate direct material, labor and equipment costs. The UPB for all Army JOCs is based on USACEs Micro Computer-Aided Cost Estimated System (MCACES)(Cassel & Gilday, 1997). The MEDJOC UPB is a variant of MCACES developed by the U.S. Army Center for Public Works (USACPW) and contains approximately 5,000 medical-specific tasks added to MCACES (J. A. Khatena, personal communication, February, 2000). Items not in the UPB are called non-prepriced items (NPI) or non-prepriced work (NPP) and prices for such are negotiated into the contract, and usually cannot exceed 10% of the total delivery order. Thus, the construction cost of a project is the sum of all UPB and NPP[4] line items, multiplied by respective quantity, multiplied by the contractor's coefficient (see formula below)(Cassel & Gilday, 1997).

$$\sum(\text{UPB or NPP line item X quantity of item X coefficient})$$

Work plan costs are calculated using a matrix that incorporates a rough estimate of construction cost and geographical region of the country[5] (Travis, 2000). One must remember that the work plan cost is applied toward, not added to, the total cost of construction.

Both the contractor and the government (i.e. Fort Worth District) each review the customer's requirements to independently develop a construction estimate. Since both the UPB line items and contractor's coefficient are fixed, negotiation comes in the form of the government and the contractor reconciling the quantity of each UPB line item.

## Remediation contracting vehicles

There is no minimum or maximum value for an individual delivery order under either Remediation vehicle, but delivery orders below 200,000 dollars may not be cost effective due to administrative burdens (G. L. East, personal communication, March, 2000). Unlike MEDJOCs, Remediation work plan costs are not applied toward construction. A critical difference also exists in pricing of delivery orders. Unlike MEDJOC procedures, the Remediation vehicles' pricing method does not include a unit price book. Each delivery order is a negotiated procurement (G. L. East, personal communication, March, 2000). This gives the contractor much greater ability to influence pricing than under MEDJOC. However, as will be discussed later, the government counters this ability by enabling the contracting vehicle manager to compete contractors against one another to get the best price. Huntsville, unlike Mobile, may issue a single delivery order for the development of the work plan and actual construction. This may serve as incentive to contractors to keep overall prices lower. This too will be discussed in a subsequent section of the paper.

Selection of prime contractor(s)

The method of choosing contractors for any contract is based on the source selection criteria (SSC). The source selection criteria for MEDJOC, as well as the two Remediation contracts are a combination of cost, technical expertise and past performance[6] of the contractor. However, the SSCs for the three contracting vehicles contain some specific differences.

MEDJOC

According to the Army Federal Acquisition Regulation Supplement (Department of the Army, 1996a), JOC SSCs are "...based on an integrated assessment of capability and past performance, technical and management proposals, sample task proposal, and the coefficient(s)" (Section 17.9003-1 (c)). The main difference between this and the Remediation SSC is the coefficient. The coefficient is a numerical factor that represents those costs not included in the UPB. The coefficient includes profit, equipment rental, bonding, general administration, overhead, insurance, protective clothing, etc. (Department of the Army, 1996a). Since all direct costs are defined in the UPB, the coefficient is the only cost factor considered in the MEDJOC contractor selection process.

For both MEDJOC and Remediation, a technical panel consisting of experts from both USACE and USAMEDCOM will also evaluate each contractor's proposal based upon its adherence to the government's solicitation. In all contracting vehicles, the technical panel may request contractors to submit a "dummy" proposal for an item of work to further evaluate both cost and technical expertise (G. L. East, personal communication, March, 2000).

## Remediation contracts

Since neither of the Remediation contracts has a UPB, neither has a coefficient per se. Thus, the cost factor considered in the SSC is each contractor's overhead. Because the contractor may be required to perform work anywhere in the country, the overhead is evaluated as it differs across 12 geographic regions. The technical panel also evaluates contractors' past performance (N. Chong & K. Jones, personal communication, February, 2000).

## Flexibility with prime contractors

The MEDJOC vehicle possesses a different level of flexibility with its prime contractor than the Remediation vehicles have with theirs. However, both the Huntsville and Mobile contracting vehicles share similar flexibility.

MEDJOC

One contractor holds all MEDJOC contracts for the entire country. Therefore, Fort Worth District has only a few tools to encourage better performance from the contractor, should it become necessary to do so. The first is liquidated damages (LDs). LDs, though officially non-punitive in nature, are a pre-negotiated cash amount per day the contractor must pay the government if completion is delayed. LDs can only be used in specific circumstances (Cassel & Gilday, 1997) and Fort Worth District claims to use them very seldomly (J. A. Khatena, personal communication, February, 2000). Another method of leveraging the contractor, although less immediate than LDs, is non-renewal of option years to the contract.

The final tool is not an official method, yet it is probably the most effective; word of mouth. The Army medical FM community is cohesive, and news of a poorly executed contract circulates quickly. Since, FMs can choose any of the three contracting vehicles, a bad reputation on the part of the single MEDJOC contractor may drastically reduce the number of delivery orders for the MEDJOC program and its contractor (B. W. Richmond, personal communication, January, 2000).

Remediation contracts

Huntsville and Mobile districts have the same tools available to them as MEDJOC. In addition, however, Huntsville and Mobile have a tool at their disposal that may affect more immediate improvements in contractor performance. Unlike MEDJOC, several[7] contractors participate in each of the Remediation contracts. Thus, each of the two contracting vehicle managers can influence a poorly performing contractor by awarding new delivery orders for projects to other contractors in the pool. Even among adequately performing contractors, such flexibility promotes healthy competition and may result in products better suited to the user's needs. For example, in development of work plans, Huntsville or Mobile may task more than one contractor to develop a plan, then have a technical board choose the best one (G. L. East, personal communication, March, 2000).

Along these same lines, both Remediation vehicles have the option of awarding the construction of a project to a contractor other than the one that developed the work plan. Mobile must establish a separate delivery order for the work plan and for the construction, although they may award both to the same contractor. Huntsville, conversely, can establish one delivery order for both work plan and construction, although it often awards separate delivery orders for each in order to promote competition (G. L. East, personal communication, March 2000). One might infer, since Mobile must establish a separate delivery order for construction, that the quality of its work plans is better than Huntsville's since Mobile's may have an increased chance of having to stand alone. No known study has addressed this issue. The results of this study, as they apply to this issue, will be briefly addressed in the Discussion of Analyses section.

## Discussion of Analyses

This portion of the discussion will first discuss aggregate results at the overall, infrastructure and functional levels. The second portion will analyze the results of each scope category. Due to the scarcity of project data in most scope categories, the discussions will often rely heavily upon the experience of the researcher or the team members, or both.

Before attempting to evaluate contracting vehicles for each scope category, the reader should be made aware of findings regarding project modifications and cost overruns. Since modification data was judged unreliable, it was not used to make evaluations on an MST's quality. In addition, the researcher ran one-way analysis of variance (ANOVA) tests to determine if the construction and total cost overrun means for aggregate functional, infrastructure, and overall (functional and infrastructure) categories were significantly different. The resulting P-values greatly exceeded a (.05), indicating that differences between the means of the three MSTs were not statistically significant (see Tables 10, 11 and 12). Since Fort Worth's n-values were far lower than those of Mobile and Huntsville, the researcher ran the same ANOVAs again, but excluded Fort Worth data. Again, P-values greatly exceeded .05 (see Tables 10, 11 and 12). Therefore, the researcher posits that, due to the limited sample size of this study, cost overruns cannot be used to definitively determine the quality or value of a particular MST versus another, even in the aggregate. The same is therefore true for individual scope categories since no n-values ever exceed single digits there.

Despite lack of statistical significance, however, the means shown in Table 9 indicate a trend may exist for Mobile's cost overruns to be less than Huntsville's for aggregate overall (functional and infrastructure), functional, and infrastructure categories. Fort Worth's cost overrun percentages were lower than both Mobile and

Huntsville in both the functional and overall categories, but more Fort Worth projects must be evaluated before any sort of trend for it can even be suggested. Cost overrun data for individual scope categories has the same limitations as the aggregate categories, but may still potentially indicate the MST with lowest cost overruns for a particular scope. Despite lack of definitive data, all means and percentages provide a valuable basis for future research.

Scope category discussions.

In all scope category discussions, more projects than are currently available must be evaluated before any conclusions can be drawn with any confidence. Since this fact is true for all scope categories, it will not be repeated for each category.

Veterinary clinics

In the Veterinary Clinic category (see Table 7), both projects were quite similar, except that the Fort Worth project also included construction of a kennel, the cost per GSF of which would be cheaper than clinic space. This may have artificially lowered the cost per GSF of the Fort Worth project to its indicated level below that of Mobile. Despite the potentially confounded cost per GSF, the Fort Worth project finished according to the programmed budget, while Mobile’s finished under budget. These observations lead the researcher to believe that, in this case, Mobile may have been the better MST in terms of cost and quality.

### General clinics

Each of these projects (see Table 7) involved substantial construction of interior walls, renovation of HVAC, lighting, etc. One might argue that Huntsville’s higher cost per GSF is due to the fact that it was performed in geographically isolated Hawaii. However, fire sprinkler and elevator projects in Hawaii from this study did not indicate substantially higher costs per unit of measure than other projects in those categories. Huntsville’s cost per GSF is nearly twice that of Mobile’s, and Huntsville finished more than ten percent over budget while Mobile was actually under budget. Also, despite a budget nearly 5.8 times greater than Mobile, Huntsville seemed to fail to realize any economies of scale. These all point toward projects that deviated substantially from plans, indicating that Mobile may have provided the best quality and value for the general clinic construction dollar.

## Dental clinics

There is not enough data to draw any conclusions in this scope category (see Table 7). The table only provides a basis for future study.

## Inpatient areas

A sample size of one for each MST (see Table 7) can hardly lead to a definitive conclusion. However, Mobile's project required more than twice the cost per GSF to renovate, even though Huntsville's entailed construction of 11 individual ICU rooms and Mobile's consisted essentially of a simpler open bay ICU design. In these two particular projects, the data indicates that Huntsville may have provided the best quality and most effective means of investing construction dollars.

## Administrative areas

There is not enough data to draw any conclusions in this scope category (see Table 7). The table only provides a basis for future study.

## Chiller replacement

Both Mobile and Huntsville had enormous double-digit over budget percentages (see Table 8). Once again, the sample size is too small to facilitate sweeping conclusions. However, Mobile's cost per ton is approximately 25% cheaper than Huntsville's, even after one reduces Huntsville’s cost by its overrun. Though Mobile seems to be the better value in this case, double-digit percentage cost overages indicate that neither contracting vehicle provided acceptable costs or quality in this category.

### Primary distribution system

There is not enough data to draw any conclusions in this scope category (see Table 8). Considering that review of statements of work reduced the number of potential primary distribution system projects from five to one (see Tables 4 and 6), this scope category may be too broad to compare projects in the aggregate.

### Utility meters or FM switches

There is not enough data to draw any solid conclusions in this scope category (see Table 8). The table only provides a basis for future study.

### Transfer switches

Since there is only one project per MST in this category (see Table 8), conclusions cannot be extrapolated to other projects not included in this study. However, Mobile’s performance in both cost per UM and cost overruns is noticeably better than Fort Worth’s, indicating Mobile may be the better contracting vehicle in terms of cost and quality for this instance.

## Plant management system or HVAC controls

There is not enough data to draw any solid conclusions in this scope category (see Table 8). The table only provides a basis for future study.

## Elevators

Though Fort Worth’s sample size is much smaller than Mobile’s (see Table 8), both MST’s cost increases are in keeping with their own average cost increases for infrastructure projects (see Table 9). Both MSTs are evenly matched in cost overruns (both are minimal). Though Fort Worth’s cost per elevator is approximately 30% less than Mobile’s, Fort Worth’s limited sample size prohibits the researcher from choosing it as the best value in this category. In lieu of more data, researcher assumes that both contracting vehicles provided adequate value and quality in this category.

## Nurse call systems

There is not enough data to draw any solid conclusions in this scope category (see Table 8). The table only provides a basis for future study.

## Fire sprinklers

Since no cost per UM data exists for Huntsville’s four individual projects (see Table 8), the researcher considered that four of the five *Combination* projects are a collaboration of Huntsville and Mobile. Though far from certain, the fact that Mobile's cost per UM is 38% lower than *Combination's* leads the researcher to believe that Mobile may be less expensive than Huntsville. Though this is further evidenced by Huntsville's 6.87% run over budget compared to Mobile's 0.09% under budget finish, no definitive claim can be made in the absence of cost per UM data for Huntsville.

### Roof (membrane and asphalt shingle)

There is not enough data to draw any solid conclusions in either of these scope categories (see Table 8). The table only provides a basis for future study.

## Final Discussion

The researcher had hoped to compare the three contracting vehicles via timeliness, quality and cost. However, the study yielded few timeliness and no quality-related findings. Only partial cost determinations could be made, and the data that supported them were not statistically significant.

However, this study was far from a failure. It highlighted two overarching problems facing the AMEDD facilities management and planning community; lack of data and lack of metrics. Less than ten years ago, the method of physical management of AMEDD facilities consisted of a system characterized often by inadequately trained facility managers operating under nearly non-existent central control. In the relatively brief time period since, the USAMEDCOM has transitioned it into a system of well-trained FMs operating in cooperation with a series of agencies (ACSIE&FM, USAHFPA and USACE) designed to provide resources and expertise rather than strong central control. Though this empowers the facility manager to make decisions that benefit his or her facility, the unfortunate result of the rapid transition to this intentionally loose command structure is the lack of data and metrics to adequately and consistently measure the effectiveness of many programs. Deciding which data to use, and how to analyze it, should have been the most difficult portion of this study. Instead, merely learning what data was available and obtaining it became a nearly all-encompassing endeavor that required the researcher to coordinate with 15 different individuals, in 11 different agencies or branches, located from Hawaii to the District of Columbia. Furthermore, though individuals within it may know, the AMEDD institutionally lacks the knowledge to adequately keep abreast of all the programs and metrics it employs. In other words, individuals, not the structure of the organization, make the system work as well as it currently does.

The fact that ACSIE&FM and USAHFPA requested the assistance of this researcher, however, indicates that they are aware of this problem and wish to correct it. This study will help to alleviate this problem by pointing out areas where data is unavailable, recommending methods of collection, development of metrics, and methods of oversight to assist the AMEDD in evaluating the Toolbox program on a systemic basis.

## Conclusions and Recommendations

### Conclusions

#### Contracting vehicle overview.

The AMEDD facility management and medical construction programs are markedly different from that of any civilian healthcare organization in two main aspects; personnel management, and capital improvement financing. The AMEDD members who manage these programs at all levels, particularly military personnel, move into different positions in and out of the organization with great frequency. Furthermore, military members are often placed in positions based more upon rank, rather than upon experience in the system. Secondly, due to funding restraints and the requirement to obligate funds before the end of the fiscal year, these same personnel must know where their construction dollar will be spent most effectively.

Contracting vehicle evaluations.

1. Nearly all of the data necessary to complete this study as initially proposed is used and managed by project officers, facility managers, TAT and MST personnel for every project. The problem is that little of it is retained or centrally collected after each project's completion and thus, no systemic review of cost, quality and timeliness is accomplished.

2. The literature review indicates that JOC contracting methods are less expensive than traditional contracting methods. Because many of the key features are similar, the researcher assumes the same is true for Remediation contract methods as well. Though the results of this study are not statistically significant, there is evidence of the following:

a. Mobile District may provide the lowest costs per unit of measure, and lowest cost increases in all three aggregate categories (overall, functional, and infrastructure).

b. Mobile may provide the lowest cost per UM and overall best quality in the following scope categories: veterinary clinics; general clinics; transfer switches and; fire sprinklers.

c. Huntsville may provide the best cost and quality in inpatient area renovation.

d. Mobile and Fort Worth performed equally well in elevator projects.

e. Mobile and Huntsville incurred substantial cost overruns in chiller replacement projects and neither MST may be the best choice for such projects.

3. Due to lack of available data, no comparisons of contracting vehicle timeliness can be drawn. However, the literature review indicates that the JOC method of contracting is faster than traditional contracting methods. Because many of the key features are similar, the researcher assumes the same is true for Remediation contract methods as well.

4. Though the sample size is too small to draw a definitive conclusion, it appears that MSTs collaborating on a project (i.e. one MST performs the work plan, another constructs the project, etc.) produces a synergistic effect. The result seems to be lower cost overruns than when MST’s did not collaborate on a project. This seems ironic, in that work plans are, by definition, difficult for anyone not intimately familiar with the project to

construct and execute. Further research is needed to determine why, or even if, this phenomenon exists.

Recommendations

1. The Results and Discussion portions of this paper, including Table 14, should be made readily available to such Facility Managers, ACSIE&FM, and USAHFPA personnel. The researcher recommends that these two portions, or an abridged version thereof, be placed on the ACSIE&FM (http://hfpa.otsg.amedd.army.mil/acsiefm/medindex.htm) and USAHFPA (http://hfpa.otsg.amedd.army.mil) websites, as well as those of the three MSTs. The same information should be presented at annual professional development conferences hosted by USAHFPA and ACSIE&FM and discussed at the quarterly Board of Directors and Contract Advisory Committee meetings. Dissemination of the same information should also be accomplished through USAMEDCOM facility information bulletins.

2. The scope categories and units of measure developed for this study should be further validated by future study. In particular, the primary distribution system (PDS) scope category may be too broad to facilitate comparisons between MSTs. Further sub-categorization or development of a different unit of measure for PDS may be necessary.

3. Scope categories should be developed for areas not included in this study but that are covered by Toolbox contracts, such as general HVAC, medical gas systems, etc.

4. A standard matrix should be developed to record data on modifications that indicate: general scope of the modification, quality of materials, workmanship, work plan, and expertise of contractor; deviations from work plan due lack of consideration of owner’s intended use of the area, thoroughness of site survey, etc.; and cost and timeline increases due to the same reasons stated above. The matrix should account for cost as well as “severity” of the modification.

5. A standard matrix, similar in format to that for modifications, should be developed to record data on quality.

6. A method should be developed to account for the true total costs of a project (USACE S&A, MST, TAT and FM staff salaries and expenses, etc.).

7. The Sustainment and Renewal Branches’ databases should be consolidated into one master database. The researcher recommends Microsoft Access as the medium. In addition to the 11 cost and timeliness data elements for each project (see the Retrieving Data: Calculations section of this paper), the database should contain:

a. Information on MST, installation and region

b. A summarized statement of work in a standardized format

c. Unit of measure data

d. Percentage of newly constructed versus existing areas (in terms of units of measure)

e. Modification data (see 3. above)

f. A delivery order document number system that facilitates linking of all related delivery orders for a project (e.g. the delivery order for the site visit, the delivery order for the work plan, etc.)

g. Quality assurance data (see 4. above)

h. Queries that calculate: percent over/under budget (site visit/work plan, 85% construction, total project); percent late/1early (for same categories as just specified); cost per UM; number and severity of modifications; overall quality.

8. An auditor such as the Army Audit Agency or similar organization within USAMEDCOM should continually evaluate data collection and quality. The same organization should evaluate yearly the performance of each MST as compared to the others via the above-mentioned queries. The USAMEDCOM Board of Directors and Contract Advisory Committees should evaluate these queries

themselves, as well as consider the findings and recommendations of the aforementioned audit group, in deciding how to modify the existing Toolbox program in the most efficient manner.

9. Minor modifications to this database and queries could facilitate similar evaluation of traditional military construction (MILCON) projects and comparisons between them and Toolbox contracts.

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Footnotes

[1]Circa 1994, installation Directorates of Engineering and Housing (DEH) began aligning themselves more closely with the organizational structures of their municipal counterparts. This resulted in a renaming of DEHs to DPWs. However, this change occurred over a multi-year period and at different times at different installations. Therefore, to avoid confusion in this paper, the term DPW will be used throughout, regardless of the date of the reference.

[2]U.S. Army Medical Command was provisionally activated on 1 October 1993. It existed in provisional status along with Health Services Command until 2 October 1994, when USAMEDCOM became fully activated (J. L. Harben, personal communication, December 15, 1999). To avoid confusion in this paper, the term USAMEDCOM will be used throughout, regardless of the date of the reference.

[3]In the military facilities arena, the term “construction” often refers only to specific dollar values and scopes of work, and differs greatly from the average reader’s general definition of the term. Given the design and purpose of this study, including such parochial distinctions would make this paper unnecessarily wordy. Thus, unless specifically noted, this paper defines

construction as any work that involves the building or putting together of the parts of a structure.

[4]A different coefficient is negotiated for NPP items than is used for UPB items (Department of the Army, 1996a).

[5]The two MEDJOC contracts (each currently held by the same prime contractor) collectively cover the continental United States (CONUS), Alaska, Hawaii and Puerto Rico (USAMEDCOM, 1997b). The Remediation contracts cover CONUS, Alaska, Hawaii and the Caribbean area (Republic of Panama, Puerto Rico, Virgin Islands, and Bahamas)(USAMEDCOM, 1999c). For simplicity, the term *country*, as used in this study, refers to all geographical areas covered by each respective contracting vehicle.

[6]Prior to 1998, the Federal Acquisition Regulation (FAR) severely limited contracting officials’ ability to consider past performance in source selection criteria. Changes to the FAR in 1998 encourage contracting officials to consider past performance in order to create incentives for quality among contractors (Government Executive, 1997; A. V. Burman, 1997b).

[7]At the time of this study the Huntsville Remediation contracting vehicle has four contractors eligible to participate in the Toolbox program. The Mobile vehicle has

five individual contractors, several of which have formed two separate joint ventures, bringing the total to seven.

Table 1

Basis of Comparison: Functional Areas

| Scope Category | Unit of Measure |
|---|---|
| Veterinary Clinics (New Construction) | Gross Square Footage (GSF)[a] |
| General Clinics (Renovation) | GSF[a] |
| Dental Clinics (Renovation) | GSF[a] |
| Inpatient Areas (Renovation) | GSF[a] |
| Administrative Areas (Renovation) | GSF[a] |
| Special Areas (Renovation) | GSF[a] |
| Laboratories | GSF[a] |
| Radiology | GSF[a] |
| Computer Rooms | GSF[a] |
| Maintenance/Repair Shops | GSF[a] |

[a]Differentiate between space that has been repaired or renovated versus added space that increased the GSF of the building.

Table 2
Basis of Comparison: Infrastructure Systems

| Scope Category | Unit of Measure |
|---|---|
| Chiller | Total chiller tonnage |
| Boiler | British Thermal Units (Btu) |
| Primary Distribution System | GSF of area serviced by the electrical system[a, b] |
| Utility Meters or FM Switches | Number of meters or switches installed, by type (e.g. gas, water, etc.) |
| Transfer Switches | Number and type of transfer switches repaired or replaced |
| Plant Mgmt. Systems or HVAC Controls | Number of monitored points or installed pieces of equipment, by type[b] |
| Elevators | Number of elevators |
| Nurse Call Systems | Number of peripheral devices[b] |
| Fire Sprinklers | GSF of sprinkled area[c] |
| Roof (membrane) | GSF of roof[d] |
| Roof (asphalt shingle) | GSF of roof[d] |

[a]Differentiate between repaired versus fully replaced system.

[b]Any significant pieces of additional equipment included in the project must be listed and considered.

[c] Differentiate between areas where sprinklers were repaired or replaced versus areas where no sprinkling system had been before.

[d]Differentiate between repaired roof (e.g. new surface material applied) or replaced roof (e.g. all layers removed and structural work performed) and new roof construction over a previously un-roofed area.

Table 3

Functional Projects by Scope Category and Contracting Vehicle

| Scope Category | Contracting Vehicle | | |
|---|---|---|---|
| | Fort Worth | Mobile | Huntsville |
| Veterinary Clinics (New Construction) | 1 | 2 | 0 |
| General Clinics (Renovation) | 0 | 6 | 3 |
| Dental Clinics (Renovation) | 0 | 1 | 3 |
| Inpatient Areas (Renovation) | 0 | 1 | 1 |
| Administrative Areas (Renovation) | 0 | 1 | 1 |
| Special Areas (Renovation) | 0 | 0 | 0 |
| Laboratories | 0 | 0 | 0 |
| Radiology | 0 | 0 | 0 |
| Computer Rooms | 0 | 0 | 0 |
| Maintenance/Repair Shops | 0 | 0 | 0 |

Table 4

Functional Projects by Scope Category and Contracting Vehicle

| Scope Category | Contracting Vehicle | | |
| --- | --- | --- | --- |
| | Fort Worth | Mobile | Huntsville |
| Chiller | 0 | 2 | 2 |
| Boiler | 0 | 0 | 0 |
| Primary Distribution System | 0 | 2 | 3 |
| Utility Meters or FM Switches | 0 | 3 | 1 |
| Transfer Switches | 1 | 2 | 0 |
| Plant Mgmt. Systems or HVAC Controls | 1 | 0 | 1 |
| Elevators | 1 | 5 | 0 |
| Nurse Call Systems | 1 | 1 | 0 |
| Fire Sprinklers | 0 | 7 | 0 |
| Roof (membrane) | 0 | 2 | 1 |
| Roof (asphalt shingle) | 0 | 0 | 0 |

Table 5

Functional Projects by Scope Category and Contracting Vehicle (After Final Data Collection)

| Scope Category | Contracting Vehicle | | |
|---|---|---|---|
| | Fort Worth | Mobile | Huntsville |
| Veterinary Clinics (New Construction) | 1 | 1[a] | 0 |
| General Clinics (Renovation) | 0 | 3[a] | 3 |
| Dental Clinics (Renovation) | 0 | 1 | 1[a] |
| Inpatient Areas (Renovation) | 0 | 1 | 1 |
| Administrative Areas (Renovation) | 0 | 1 | 1 |
| Special Areas (Renovation) | 0 | 0 | 0 |
| Laboratories | 0 | 0 | 0 |
| Radiology | 0 | 0 | 0 |
| Computer Rooms | 0 | 0 | 0 |
| Maintenance/Repair Shops | 0 | 0 | 0 |

[a]Projects were eliminated from the study or moved to other scope categories based upon the magnitude of their dissimilarity from all other projects in this scope category. The number shown represents the number remaining projects for a particular MST in that scope category.

Table 6

Infrastructure Projects by Scope Category and Contracting Vehicle (After Final Data Collection)

| Scope Category | Contracting Vehicle | | | |
|---|---|---|---|---|
| | Fort Worth | Mobile | Huntsville | Combination |
| Chiller | 0 | 2 | 2 | 0 |
| Boiler | 0 | 0 | 0 | 0 |
| Primary Distribution System | 0 | 1[a, c] | 0[a, b] | 0 |
| Utility Meters or FM Switches | 0 | 1[c] | 0[a] | 2 |
| Transfer Switches | 1 | 1[b] | 0 | 0 |
| Plant Mgmt. Systems or HVAC Controls | 1[c] | 0 | 0[a] | 1 |
| Elevators | 1 | 5 | 0 | 0 |
| Nurse Call Systems | 1[c] | 0[a] | 0 | 0 |
| Fire Sprinklers | 0 | 7 | 4 | 5 |
| Roof (membrane) | 0 | 2[c] | 0[b] | 0 |
| Roof (asphalt shingle) | 0 | 0 | 1[c] | 0 |

Note: Numbers shown represent the final number of projects considered in each category. Superscript letters indicate where projects were moved or deleted from their original locations in Table 3 for the reasons indicated below.

[a]Insufficient data available.

[b]Too dissimilar from other projects in that scope category.

[c]Due to other eliminated projects, remaining number in scope category has no comparable project in another MST.

Table 7

Average Costs by Scope Category (Functional)

| Scope Category: Veterinary Clinic (New Construction) | | | |
|---|---|---|---|
| | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
| Overall (all MSTs) | $88<br>n=2 | (2.50)%<br>n=2 | $334,183<br>n=2 |
| Mobile | $103<br>n=1 | (5.10)%<br>n=1 | $284,705<br>n=1 |
| Fort Worth | $80[a]<br>n=1 | 0.00%<br>n=1 | $383,660<br>n=1 |

[a] The Fort Worth project included a kennel, which is cheaper to construct per GSF than veterinary clinic space.

| Scope Category: General Clinics (Renovation) | | | |
|---|---|---|---|
| Overall (all MSTs) | $145<br>n=7 | 4.25%<br>n=7 | $1,978,532<br>n=7 |
| Mobile | $135<br>n=4 | (0.20)%<br>n=4 | $615,399<br>n=4 |
| Huntsville | $240<br>n=3 | 10.19%<br>n=3 | $3,552,613<br>n=3 |

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 7 (Continued)

Average Costs by Scope Category (Functional)

Scope Category: Dental Clinics (Renovation)

| | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
|---|---|---|---|
| Overall (all MSTs) | NA | NA | NA |
| Huntsville | $243 | 0.00% | $2,548,663 |
| | n=2 | n=2 | n=2 |

Scope Category: Inpatient Areas (Renovation)

| | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
|---|---|---|---|
| Overall (all MSTs) | $170 | 2.59% | $658,361 |
| | n=2 | n=2 | n=2 |
| Mobile | $286[a] | 1.74% | $686,747 |
| | n=1 | n=1 | n=1 |
| Huntsville | $118[a] | 3.44% | $629,974 |
| | n=1 | n=1 | n=1 |

[a] The Mobile project was an “open bay” NICU design while the Huntsville project was a SICU with 11 patient rooms.

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 7 (Continued)

Average Costs by Scope Category (Functional)

| Scope Category: Administrative Areas[a] (Renovation) | | | |
|---|---|---|---|
| | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
| Overall (all MSTs) | NA | NA | NA |
| Huntsville | $26 | 0.00% | $354,997 |
| | n=2 | n=2 | n=2 |

[a] Each project consisted of areas such as community health nursing, industrial hygiene, occupational health, social work services, etc. Though clinical in nature, the team decided that the construction and materials requirements for such areas are more akin to administrative areas than general clinics.

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 8

Average Costs by Scope Category (Infrastructure)

| Scope Category: Chiller Replacement | | | |
|---|---|---|---|
| | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
| Overall (all MSTs) | $426<br>n=4 | 21.42%<br>n=4 | $469,131<br>n=4 |
| Mobile | $337<br>n=2 | 25.26%<br>n=2 | $404,438<br>n=2 |
| Huntsville | $534<br>n=2 | 17.58%<br>n=2 | $533,824<br>n=2 |
| **Scope Category: Primary Distribution System** | | | |
| Overall (all MSTs) | NA | NA | NA |
| Mobile | $145<br>n=1 | 0.00%<br>n=1 | $595,000<br>n=1 |

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 8 (Continued)

Average Costs by Scope Category (Infrastructure)

| Scope Category: Utility Meters or FM Switches | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
| --- | --- | --- | --- |
| Overall (all MSTs) | $15,614<br>n=2 | 2.35%<br>n=4 | $359,113<br>n=2 |
| Mobile | $11,670<br>n=1 | 7.92%<br>n=1 | $245,080<br>n=1 |
| Huntsville | NA | 0.00%<br>n=1 | $582,756<br>n=1 |
| Combinations | $18,926<br>n=1 | 0.75%<br>n=1 | $473,145<br>n=1 |
| **Scope Category: Transfer Switches** | | | |
| Overall (all MSTs) | $26,565<br>n=2 | 5.32%<br>n=3 | $345,346<br>n=2 |
| Mobile | $18,190<br>n=1 | 0.00%<br>n=1 | $254,656<br>n=1 |
| Fort Worth | $36,336<br>n=1 | 9.01%<br>n=1 | $436,036<br>n=1 |

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 8 (Continued)

Average Costs by Scope Category (Infrastructure)

| Scope Category: Plant Management Systems or HVAC Controls | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
|---|---|---|---|
| Overall (all MSTs) | NA | 0.00% n=2 | $632,785 n=2 |
| Huntsville | NA | 0.00% n=1 | $900,000 n=1 |
| Fort Worth | $1,654 n=1 | 0.00% n=1 | $365,570 n=1 |
| **Scope Category: Elevators** | | | |
| Overall (all MSTs) | $164,419 n=6 | 2.54% n=6 | $439,258 n=6 |
| Mobile | $175,634 n=5 | 1.50% n=5 | $497,776 n=5 |
| Fort Worth | $125,167 n=1 | 2.75% n=1 | $500,666 n=1 |

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 8 (Continued)

Average Costs by Scope Category (Infrastructure)

Scope Category: Nurse Call Systems

| | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
|---|---|---|---|
| Overall (all MSTs) | NA | 0.83% n=2 | $259,949 n=2 |
| Mobile | NA | 1.65% n=1 | $269,897 n=1 |
| Fort Worth | $115 n=1 | 0.00% n=1 | $250,000 n=1 |

Scope Category: Fire Sprinklers

| | | | |
|---|---|---|---|
| Overall (all MSTs) | $5.29[a] n=10[a] | 1.68% n=16 | $774,390 n=16 |
| Mobile | $3.75 n=7 | (0.09)% n=7 | $644,106 n=7 |
| Huntsville | NA | 6.87% n=4 | $617,015 n=4 |
| Combination | $6.02 n=5 | 0.00% n=5 | $541,415 n=5 |

[a] Mobile and *Combination* projects only, Huntsville's individual projects were not included in this figure.

Note: In all three numerical columns, "n" indicates number of projects surveyed.

Table 8 (Continued)

Average Costs by Scope Category (Infrastructure)

| Scope Category: Replace Roof (membrane) | Cost per UM | Tot. Cost-% Over (Under) | Cost per Project |
|---|---|---|---|
| Overall (all MSTs) | NA | NA | NA |
| Mobile | $7.89<br>n=2 | 6.58%<br>n=2 | $947,361<br>n=2 |
| **Scope Category: Replace Roof (asphalt)** | | | |
| Overall (all MSTs) | NA | NA | NA |
| Huntsville | $7.38<br>n=1 | (8.11)%<br>n=1 | $807,351<br>n=1 |

Note: In all three numerical columns, “n” indicates number of projects surveyed.

Table 9

Average Cost—Percent Over/(Under) Budget

Overall (Infrastructure & Functional)

| | Site Visit | Work Plan | Construction | Total |
|---|---|---|---|---|
| Overall (all MSTs) | 0.00% | (0.33)% | 4.00% | 2.95% |
| | n=13 | n=33 | n=65 | n=65 |
| Mobile | 0.00% | (1.22)% | 4.03% | 2.15% |
| | n=4 | n=20 | n=35 | n=35 |
| Huntsville | 0.00% | 1.12% | 5.95% | 5.80% |
| | n=8 | n=12 | n=18 | n=18 |
| Fort Worth | NA | NA | 2.10% | 2.10% |
| | | | n=5 | n=5 |
| Combinations | 0.00% | 0.00% | 0.22% | 0.21% |
| | n=1 | n=1 | n=7 | n=7 |

Infrastructure

| | Site Visit | Work Plan | Construction | Total |
|---|---|---|---|---|
| Overall (all MSTs) | 0.00% | (1.33)% | 4.52% | 2.85% |
| | n=7 | n=16 | n=40 | n=40 |
| Mobile | 0.00% | (2.30)% | 5.37% | 1.78% |
| | n=2 | n=9 | n=18 | n=18 |
| Huntsville | 0.00% | 0.00% | 6.57% | 6.38% |
| | n=4 | n=6 | n=11 | n=11 |
| Fort Worth | NA | NA | 2.63% | 2.63% |
| | | | n=4 | n=4 |
| Combinations | 0.00% | 0.00% | 0.22% | 0.21% |
| | n=1 | n=1 | n=7 | n=7 |

Note: In all three numerical columns, “n” indicates number of projects surveyed that contained data related to the column.

Table 9 (continued)

Average Cost—Percent Over/(Under) Budget

Functional

| | Site Visit | Work Plan | Construction | Total |
|---|---|---|---|---|
| Overall (all MSTs) | 0.00% | (0.58)% | 3.17% | 3.11% |
| | n=7 | n=17 | n=25 | n=25 |
| Mobile | 0.00% | (0.33)% | 2.62% | 2.55% |
| | n=2 | n=11 | n=17 | n=17 |
| Huntsville | 0.00% | 2.24% | 4.97% | 4.90% |
| | n=5 | n=6 | n=7 | n=7 |
| Fort Worth | NA | NA | 0.00% | 0.00% |
| | | | n=1 | n=1 |
| Combinations | NA | NA | NA | NA |

Note: In all four numerical columns, “n” indicates number of projects surveyed that contained data related to the column.

Table 10

Analysis of Variance for Overall (Functional & Infrastructure) *Construction* Cost—Percent Over/(Under)

Groups: Mobile, Huntsville, Fort Worth

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0074 | 2 | 0.0037 | 0.39858 | 0.6732 | 3.165 |
| Within Groups | 0.51086 | 55 | 0.00929 | | | |
| | | | | | | |
| Total | 0.51826 | 57 | | | | |

Groups[a]: Mobile, Huntsville

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0044 | 1 | 0.0044 | 0.4404 | 0.5099 | 4.0304 |
| Within Groups | 0.5047 | 51 | 0.0099 | | | |
| | | | | | | |
| Total | 0.5091 | 52 | | | | |

[a] Due to the comparatively small n-value of Fort Worth, this portion of the table shows the result of running an ANOVA using only Mobile and Huntsville data. This was run to help indicate whether a difference existed between the means of these two groups.

Table 10 (Continued)

Analysis of Variance for Overall (Functional & Infrastructure) *Total* Cost—Percent Over/(Under)

Groups: Mobile, Huntsville, Fort Worth

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0166 | 2 | 0.0083 | 0.4954 | 0.612 | 3.165 |
| Within Groups | 0.9211 | 55 | 0.0167 | | | |
| | | | | | | |
| Total | 0.9377 | 57 | | | | |

Groups[a]: Mobile, Huntsville

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0158 | 1 | 0.0158 | 0.8825 | 0.3519 | 4.0304 |
| Within Groups | 0.915 | 51 | 0.0179 | | | |
| | | | | | | |
| Total | 0.9308 | 52 | | | | |

[a] Due to the comparatively small n-value of Fort Worth, this portion of the table shows the result of running an ANOVA using only Mobile and Huntsville data. This was run to help indicate whether a difference existed between the means of these two groups.

Table 11

Analysis of Variance for Functional *Construction* Cost—Percent Over/(Under)

Groups: Mobile, Huntsville, Fort Worth

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0038 | 2 | 0.0019 | 0.19 | 0.8283 | 3.4434 |
| Within Groups | 0.2203 | 22 | 0.01 | | | |
| | | | | | | |
| Total | 0.2241 | 24 | | | | |

Groups[a]: Mobile, Huntsville

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0028 | 1 | 0.0028 | 0.2753 | 0.605 | 4.3009 |
| Within Groups | 0.2203 | 22 | 0.01 | | | |
| | | | | | | |
| Total | 0.223 | 23 | | | | |

[a] Due to the comparatively small n-value of Fort Worth, this portion of the table shows the result of running an ANOVA using only Mobile and Huntsville data. This was run to help indicate whether a difference existed between the means of these two groups.

Table 11 (Continued)

Analysis of Variance for Functional *Total* Cost—Percent Over/(Under)

Groups: Mobile, Huntsville, Fort Worth

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0037 | 2 | 0.0019 | 0.1939 | 0.8251 | 3.4434 |
| Within Groups | 0.2119 | 22 | 0.0096 | | | |
| | | | | | | |
| Total | 0.2156 | 24 | | | | |

Groups[a]: Mobile, Huntsville

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0027 | 1 | 0.0027 | 0.2834 | 0.5998 | 4.3009 |
| Within Groups | 0.2119 | 22 | 0.0096 | | | |
| | | | | | | |
| Total | 0.2146 | 23 | | | | |

[a] Due to the comparatively small n-value of Fort Worth, this portion of the table shows the result of running an ANOVA using only Mobile and Huntsville data. This was run to help indicate whether a difference existed between the means of these two groups.

Table 12

Analysis of Variance for Infrastructure *Construction* Cost—Percent Over/(Under)

Groups: Mobile, Huntsville, Fort Worth

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0046 | 2 | 0.0023 | 0.2429 | 0.7858 | 3.3158 |
| Within Groups | 0.2823 | 30 | 0.0094 | | | |
| | | | | | | |
| Total | 0.2869 | 32 | | | | |

Groups[a]: Mobile, Huntsville

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.001 | 1 | 0.001 | 0.0954 | 0.7598 | 4.21 |
| Within Groups | 0.2767 | 27 | 0.0102 | | | |
| | | | | | | |
| Total | 0.2777 | 28 | | | | |

[a] Due to the comparatively small n-value of Fort Worth, this portion of the table shows the result of running an ANOVA using only Mobile and Huntsville data. This was run to help indicate whether a difference existed between the means of these two groups.

Table 12 (Continued)

Analysis of Variance for Infrastructure *Total* Cost—Percent Over/(Under)

Groups: Mobile, Huntsville, Fort Worth

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0147 | 2 | 0.0074 | 0.3127 | 0.7338 | 3.3158 |
| Within Groups | 0.7072 | 30 | 0.0236 | | | |
| Total | 0.722 | 32 | | | | |

Groups[a]: Mobile, Huntsville

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 0.0145 | 1 | 0.0145 | 0.5565 | 0.4621 | 4.21 |
| Within Groups | 0.7016 | 27 | 0.026 | | | |
| Total | 0.7161 | 28 | | | | |

[a] Due to the comparatively small n-value of Fort Worth, this portion of the table shows the result of running an ANOVA using only Mobile and Huntsville data. This was run to help indicate whether a difference existed between the means of these two groups.

Table 13

Average Number of Modifications per Project

Overall (Infrastructure & Functional)

| | Average Number of Modifications per Project | Number of Projects |
|---|---|---|
| Overall (all MSTs) | 1.00 | n=65 |
| Mobile | 1.24 | n=35 |
| Huntsville | 0.70 | n=18 |
| Fort Worth | 0.80 | n=5 |
| Combinations | 0.71 | n=7 |

Functional

| | Average Number of Modifications per Project | Number of Projects |
|---|---|---|
| Overall (all MSTs) | 1.24 | n=25 |
| Mobile | 1.47 | n=17 |
| Huntsville | 0.57 | n=7 |
| Fort Worth | 2.00 | n=1 |
| Combinations | NA | NA |

Infrastructure

| | Average Number of Modifications per Project | Number of Projects |
|---|---|---|
| Overall (all MSTs) | 0.85 | n=40 |
| Mobile | 1.02 | n=18 |
| Huntsville | 0.79 | n=11 |
| Fort Worth | 0.50 | n=4 |
| Combinations | 0.71 | n=7 |

Note: In both numerical columns, "n" indicates number of projects surveyed that contained data related to the column.

Table 14

Salient Features of Each Contracting Vehicle

| Feature | Contracting Vehicle | | |
|---|---|---|---|
| | Fort Worth | Mobile | Huntsville |
| IDIQ | Yes | Yes | Yes |
| Work Plans (WP) Only | Yes | Yes | Yes |
| WP & Construction Performed by Same Contractor (Ktr) | Always | Allowed | Allowed |
| Separate Delivery Orders (DO) Required for WP & Construction | No | Yes | No |
| WP Cost Applied toward Construction Cost | Yes | No | No |
| Funding Limits per DO | $25,000 - $300,000[a] | None[b] | None[b] |
| Method of Pricing Individual DOs | UPB x Coefficient | Negotiated | Negotiated |
| Current Number of Ktrs | 1 | 5 | 4 |
| Source Selection Criteria | Coefficient[c] | Overhead[c] | Overhead[c] |
| Primary Leverage Over Ktr | [d] | Compete Ktrs Against Each Other[d] | Compete Ktrs Against Each Other[d] |

[a] Up to $2 million with waiver from regional medical commander or installation commander

[b] Below 200,000 dollars may not be cost effective due to administrative burdens.

Table 14 (continued)

Salient Features of Each Contracting Vehicle

[c] All three MSTs' Source Selection Criteria include contractor technical expertise, capability and past performance.

[d] All three MSTs may leverage contractors via liquidated damages and non-renewal of contract option years.